SCIENTIFIC AMERICAN SUPPLEMENT No. 180

Scientific American Supplement, Vol. VII., No. 180.
Scientific American, established 1845.

NEW YORK, JUNE 14, 1879.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

PIAT'S PORTABLE OSCILLATING FOUNDRY FURNACES.

THE accompanying illustrations show an important improvement in the construction of furnaces for melting copper, steel, and other metals that require the use of crucibles for this purpose. This new apparatus, due to M. A. Piat, of Paris, is claimed to fully realize two conditions that are essential in every invention that really marks a progress in the arts —economy of labor, and greater security for the laborer.

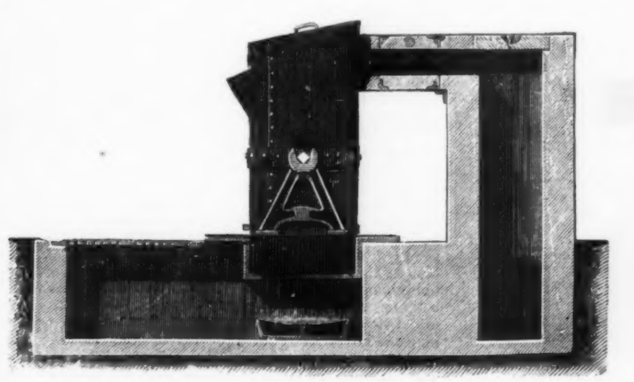


FIG. 1.—REVERBERATORY FURNACE, OF 70 TO 140 LB. CAPACITY.

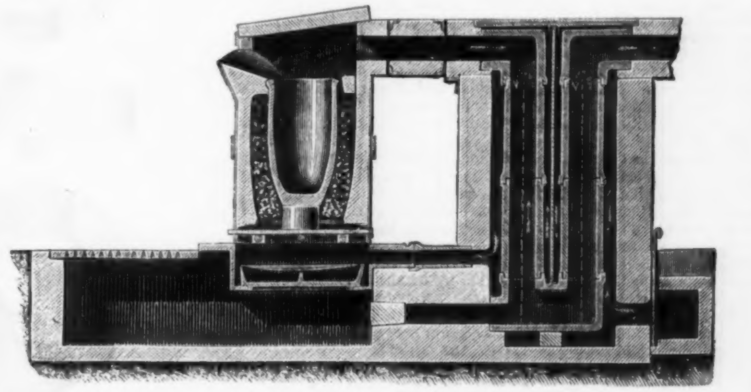


FIG. 2.—BLAST FURNACE, OF 70 TO 800 OR MORE LB. CAPACITY.

The furnace (Fig. 1) is constructed of boiler plate, and of a square form, thus permitting of great economy being realized in fuel, since the coke lodges in the corners and the crucible part, tangential to the furnace walls, being thus brought in as close contact with the crucible as possible. A strong iron band, furnished with a couple of trunnions, surrounds it at such a height as to allow it to be easily tilted by means of levers. It is by means of these same trunnions that the furnace is lifted, aided by levers, if it is to be carried by men; or, by the aid of a crane, if the furnace is too heavy to be lifted by men. In some cases it is preferable to swing the furnace on these trunnions in order to pour the contents of the crucible into the ladle, to be afterwards carried to the moulds in the latter. The interior lining is made of either refractory bricks of the best quality, or refractory sand rammed down compactly.

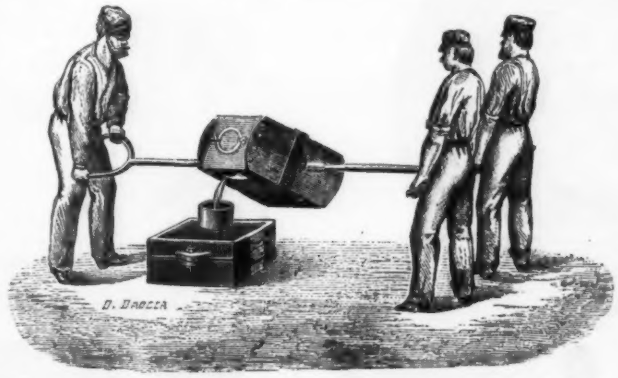


FIG. 3.—FURNACE OF 70 TO 80 LB. CAPACITY CARRIED BY TWO OR THREE MEN.

The shape of the furnace is slightly conical at the bottom. In front there is an aperture, in the form of a spout, for the outflow of the liquid; and a larger, rectangular one is situated at the opposite side to allow the hot gases to escape. The cover is of the form in general use in foundries.

So much for the furnace, properly so called. As to the crucible, it must always be fastened in the furnace in an invariable manner; this result is reached by means (1) of a supporting piece made of refractory earth, and resting on the grate; (2) of a spout, also of refractory earth, connecting the neck of the crucible with the exterior nozzle of the furnace; and (3) of a wedge, of the same material, placed opposite to the spout and forcing the crucible to adapt itself perfectly. These various parts are little affected by the fire, and in all cases are easily replaced at slight expense.

The whole rests on two supports, with a brick or cast-iron receptacle underneath for the reception of the air or blast. The products of combustion escape above through the opening already mentioned. Whether the furnace be worked by free air or blast it is always necessary that it be provided with the orifice for leading the hot gases into the chimney, so as to facilitate the disengagement of the carbonic oxide and carbonic acid produced by the combination of the air and carbon. In the first case sufficient renewal of air is obtained when each tapping takes place; in the second case, if care be not taken to have this opening, the cover (which is placed on the furnace for protecting the founder from heat, and for keeping this heat in the furnace) does not allow a sufficient means of escape for the gases, and the consequence is poor combustion in the interior. These heated gases are the very ones which serve to warm the cold air, and by their aid a temperature of about 300° C. may be attained. For this purpose a recuperator, such as shown in Fig. 2, may be made use of; or the radiation of the furnace itself may be employed, when nothing else can be done, as in the case of the furnace with crane (Fig. 5); only, in the latter case, the temperature scarcely reaches more than 100° to 120° C.

The results thus far obtained with these furnaces, which do away with all the inconveniences attached to the old system, are said by the inventor to be in perfect accordance with his most sanguine hopes.

NEW WATER ENGINE.

ENGINES and machinery driven by the pressure of water have been gaining much favor of late, especially where the power required is intermittent. Such engines are available at any moment, are cleanly, and do not, like steam engines, increase the insurance premium; but hitherto it has been impossible, when variable loads have to be dealt with, to use hydraulic power with economy, whether the pressure comes from gravitation or the "accumulator," on account of its non-elastic nature, the result being that hydraulic engines use as much water when running idle as when working at full power. Nor is this the only disadvantage as compared with steam, for when hydraulic engines are driven from the town mains, as is most frequently the case, it is found that the pressure in these mains varies, being always highest in the mornings and evenings, and lowest during the middle of the day, when most re-

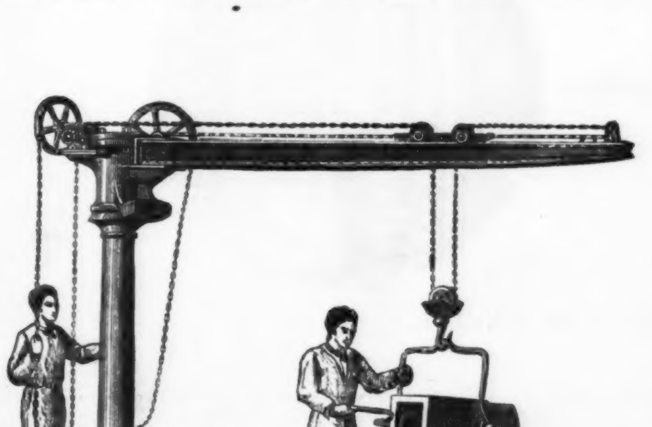


FIG. 4.—FURNACE OF 140 OR MORE LB. CAPACITY, OPERATED BY AID OF A CRANE AND ONE MAN.

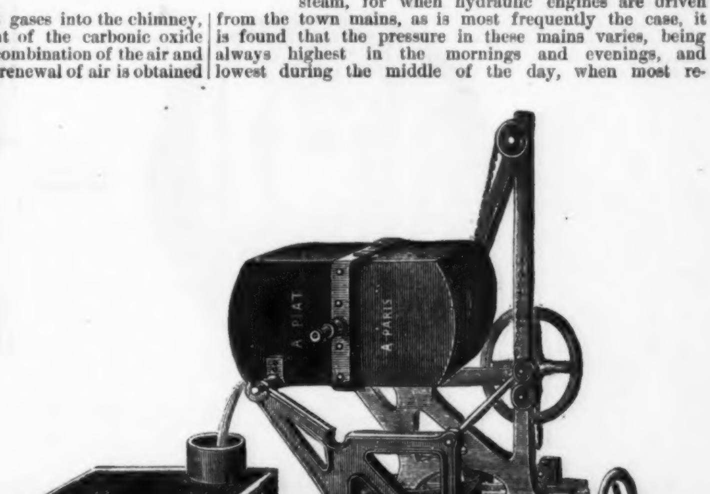


FIG. 5.—ARRANGEMENT OF FURNACE FOR CASES WHERE FOUNDERS, HAVING NO CRANE, STILL NEED TO MAKE USE OF CRUCIBLES OF A CERTAIN CAPACITY.

quired. An engineer has therefore to construct an engine of sufficient power to perform the requisite amount of work at the lowest usual pressure in the "main;" and thus at the period when the pressure is highest, a greater power is exerted, and consequently a larger quantity of water is used than is necessary, for the cylinder must be completely filled with water at every stroke, whether the power is required or not. When these two disadvantages are taken into account there is often a loss of water to the extent of from 60 to 70 per cent.

Engineers have long been sensible of these disadvantages, and no later than last year, in two papers read before the Institution of Civil Engineers, one by Sir William Armstrong, and the other by Mr. Henry Robinson, reference was made to this, both by the authors and by those who took part in the discussion which followed.

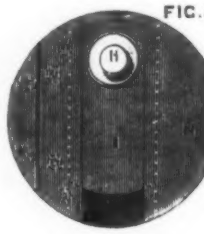
This difficulty has lately been overcome by a novel and ingenious arrangement invented and patented by Mr. John Hastie, of the firm of John Hastie & Co., Kilblain Engine Works, Greenock, Mr. Hastie's engine being constructed with simple automatic appliances, so that the amount of water used is in direct proportion to the amount of work done. If the engine is running idle, the water is only used sufficient to overcome its friction, and when more work is thrown on, extra water is used corresponding with that work. This is accomplished by making the stroke of piston of variable length, and the mechanism to accomplish this is so arranged that the engine itself makes the necessary adjustment of stroke for the power required, without assistance from and independent of any attendant.

Seven engines on this principle are already practically at work in Greenock, and have been tested as to the sensitiveness of the automatic arrangement, and Messrs. Hastie have several more in course of construction. They are adapted for working hoists and for driving all kinds of machinery.

Mr. Hastie has several adaptations of his patent, one specially for pressures up to, say, 150 lb., and another for such pressures as are used with the accumulator. Both of these we now illustrate on this page. The engravings, Figs. 1 to 6, give details of a hydraulic engine (in this case with two cylinders) constructed for the lower pressures, and the working of which will be understood from the following description. A is the inlet pipe, which by means of passages in the frame of engine, B, conveys the water to the oscillating cylinders, C and D; each of these is fitted with long trunnions, G, which contain the admission ports, and which during their oscillation act as valves; the outlet for the water is by similar passages leading to a pipe in the opposite side of framing from A. The ends of the piston rods, E and F, act direct on the crank-pin, H; this pin is formed on a sliding frame, I, which frame effects the necessary adjustment of stroke; it is formed in two pieces, an outer and an inner, bolted together at the ends, and between which is a space in which the double cam, K, works. The outer plate has a small steel roller, L, working on outer half of cam, and the inner plate a similar roller, M, working on inner half of cam. The disk, N, is keyed on the hollow shaft, O, and the cam, K, on shaft, B, reduced to pass through center of shaft, O. This latter shaft, O, has two snugs formed on it, to which chains, R, are attached; the shaft, P, has the spring case, S, keyed on it, and which contains the two springs, T. The action of this part of the arrangement is as follows: When the engine is at rest the springs have just as much pressure on them as holds the roller against the inner part of the curve of cam; this pressure is also sufficient to prevent any change in position of the crank-pin should the engine be running without load; when the load is thrown on, the springs become compressed in proportion to the amount of load; the compression of the springs alters the relative positions of the shafts, O and P, which causes the roller, L, to move along the curve of cam, at the same time shifting position of the sliding frame, I, and giving an increased stroke in proportion to the work being done. On the weight being removed the pressure on the springs causes the roller, M, working on the cam to bring the frame and crank-pin back to the inner position, and through this automatic variation of the stroke the water required is in proportion to the work done.

When a very high pressure of water is employed, such as is obtained with the accumulator, the springs are dispensed with, and an arrangement shown on Figs. 7 and 8 employed. In this arrangement two water rams, U, occupy the place of the springs; these are connected through center of shaft, P, with the supply pipe, and are therefore under the same pressure as is employed to work the engine. The chains, R, are employed in a similar manner as in connection with the springs, but instead of being wound directly on the body of shaft, O, they are wound on cams V; in this way increased power is required to force back the rams in proportion to the distance from the center of shaft at which the chain, R, acts, and the effect is identical with that obtained from the springs.

FIG. 3



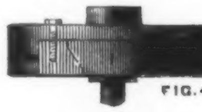


FIG. 4

FIG. 5

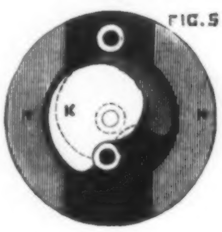


FIG 1

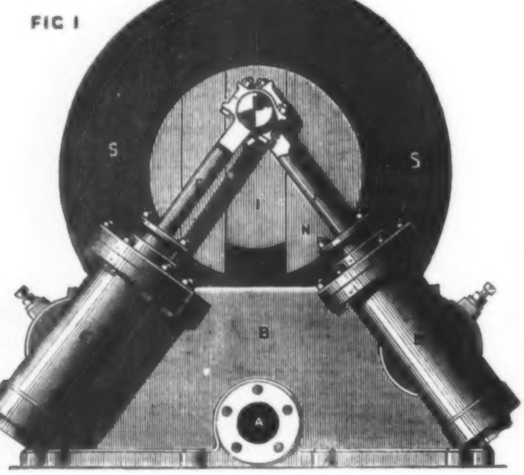


FIG 2

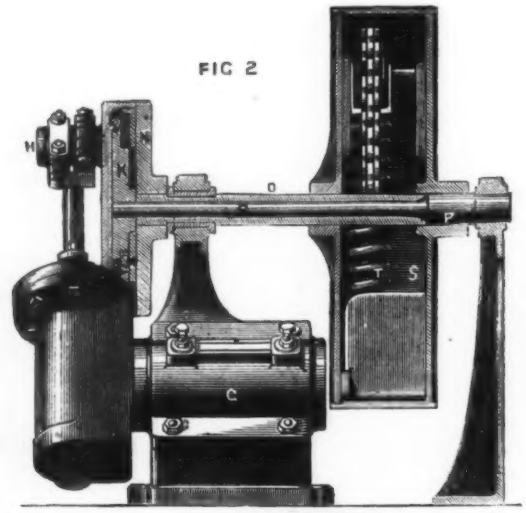


FIG 7

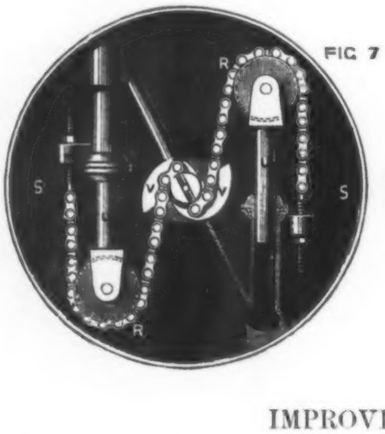


FIG 8

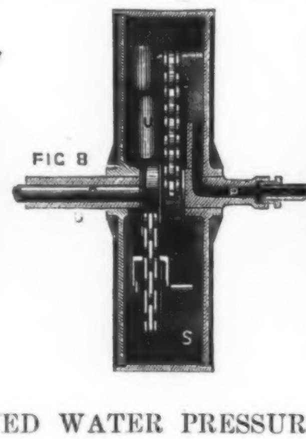
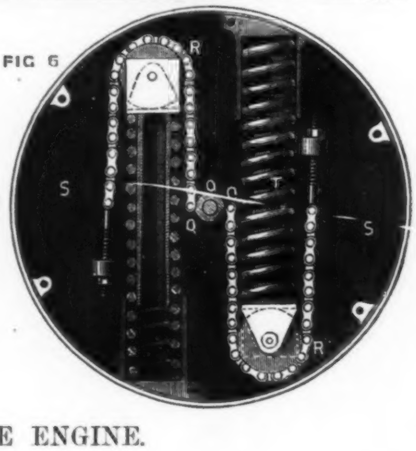


FIG 6



IMPROVED WATER PRESSURE ENGINE.

As an illustration of the working of the apparatus, it may be stated that Mr. W. R. Kinipple, M. Inst. C.E., Greenock and Westminster, and chief and consulting engineer to the Greenock Harbor Trustees, made a series of experiments with one of these engines made for the Greenock Infirmary, and attached to a hoist, the readings being made from a Siemens meter. The height of lift was 22 ft. The results were as follows:

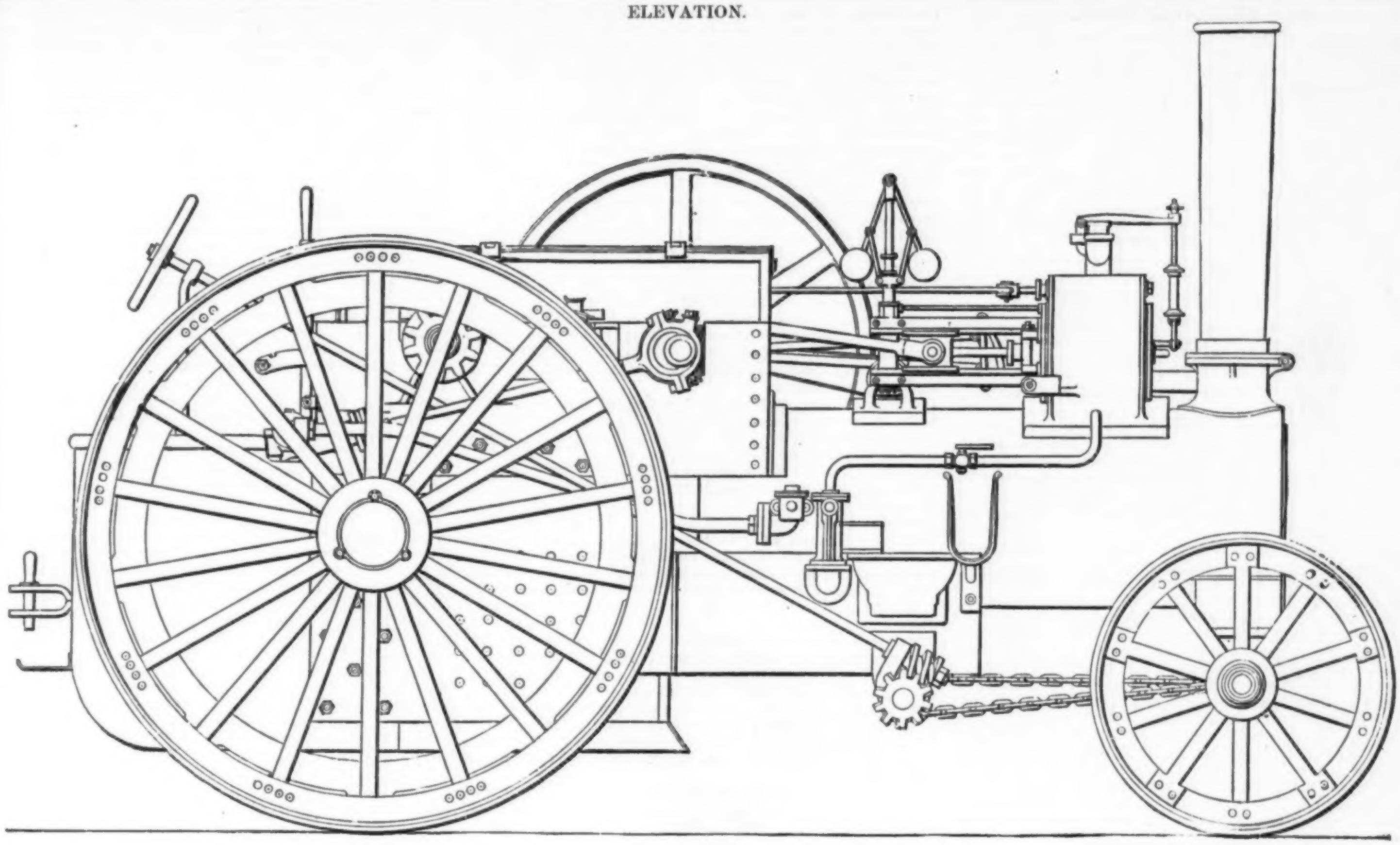
Weight lifted 22 ft. high. cwt.	qrs.	lb.	Average Water used each Lift. gallons.
3	3	7	10
5	2	17	14
6	2	17	16
7	2	17	17
8	2	17	20
9	2	17	21
10	2	17	22

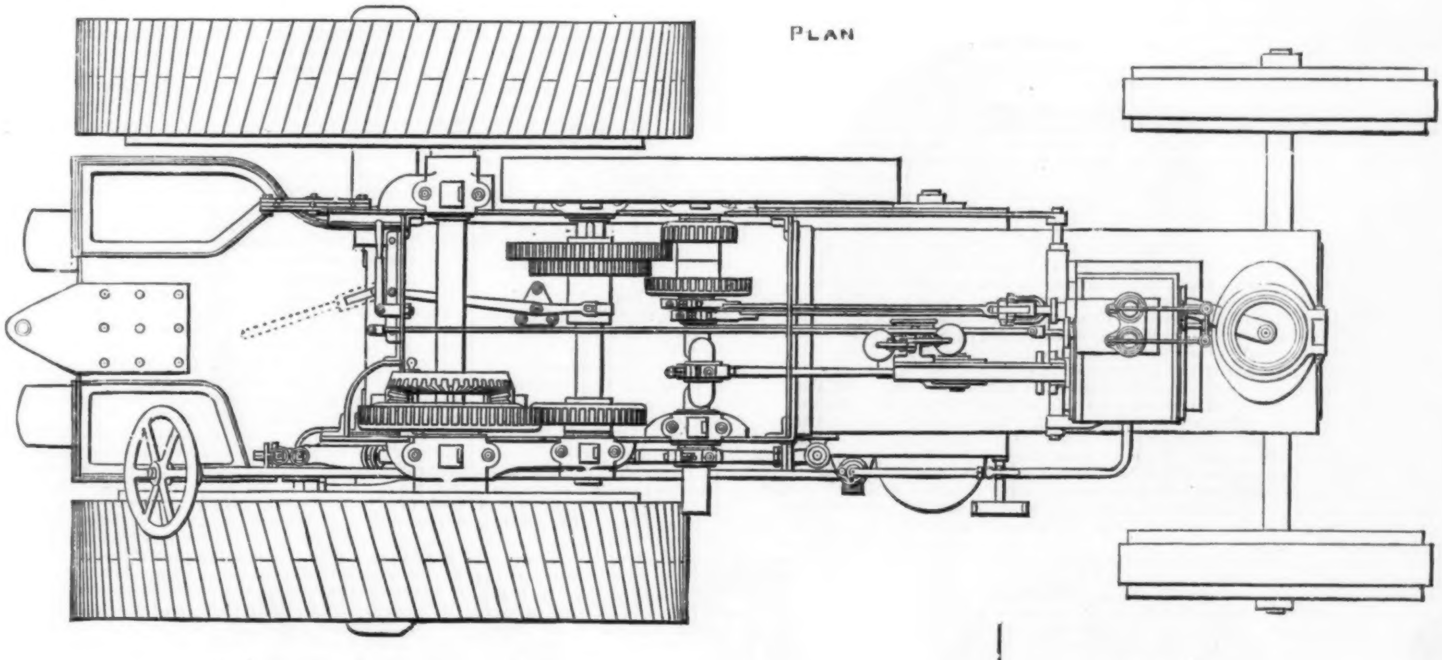
When these engines are employed for driving power apart from a hoist, they act as their own governor, as the variation of the stroke causes an equal variation of the opening of ports, and in this way a steady speed of engine is obtained whether running idle or exerting its full power, and a saving of water is also effected by the prevention of "racing" when the work is thrown off.—*Engineering.*

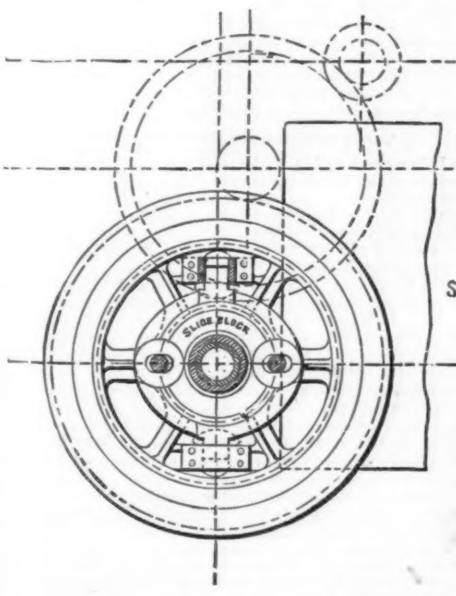
TRIAL TEST OF A NEW PATENT "BUMPER."

IT would not be truth to say that twenty-five men per week walk into the railroad offices of Detroit with a patent coupler, patent platform, patent bumpers, patent brakes, and patent something else, which they wish to sell to some company for half a million. No, the number isn't over fifteen per week, but it is steadily growing. They keep an old platform car at the Union depot for the benefit of these inventors. Whenever one appears, they give him leave to attach his patent to the car and give it a trial. The car has been overhauled so much that hardly any part of the original structure remains, and it had only been side-tracked the other day after a trial of a patent brake, which broke nothing but the inventor's shins, when along came a queer old coon from up north with a patent bumper. He took off his hat, and said they would outbump anything on earth. He shed his overcoat, and remarked that they would save the lives of 500 brakemen per year. He fell into a chair, and asserted that they exercised an economical influence on the engine, held a moral lever over the brakemen, and assured a five per cent. dividend to stockholders. They tried to make him believe that his patent was a thousand years old, and that his invention was meant to apply to milk cans and beer wagons, but they couldn't discourage him a bit. As a last resort he was given the old car. He put a carpenter and blacksmith at work, and in three days he was ready for trial. An engine was attached and the old car drawn out. The inventor stood right up to what he asserted. He said that a man between two cars provided with his patent bumpers was as safe as if in his own parlor, and when the car was backed down to a "freight," he was there to couple on. Those who didn't see him there soon heard of his presence. The bumpers were a success. They struck and jammed him so flat that his yells came forth as thin as old-fashioned three-cent pieces, and seemingly no larger. When the car was hauled away the inventor's vest buckle was found under his chin, and his silver watch down his left boot leg, and he was about as flat up and down as a plank. It would have been impossible to tell the front side from the back side but for the forethought of a small boy who picked out the side the arms were attached to and called that the front side. They took the mass over to a cheap hotel, and it is there yet. Some of the flatness has disappeared, and "it" can speak a few words, but long weeks will pass before that particular inventor will drop his old white hat on the table of another railroad superintendent.—*Detroit Free Press.*

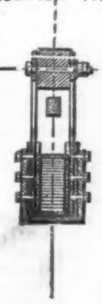
ELEVATION.

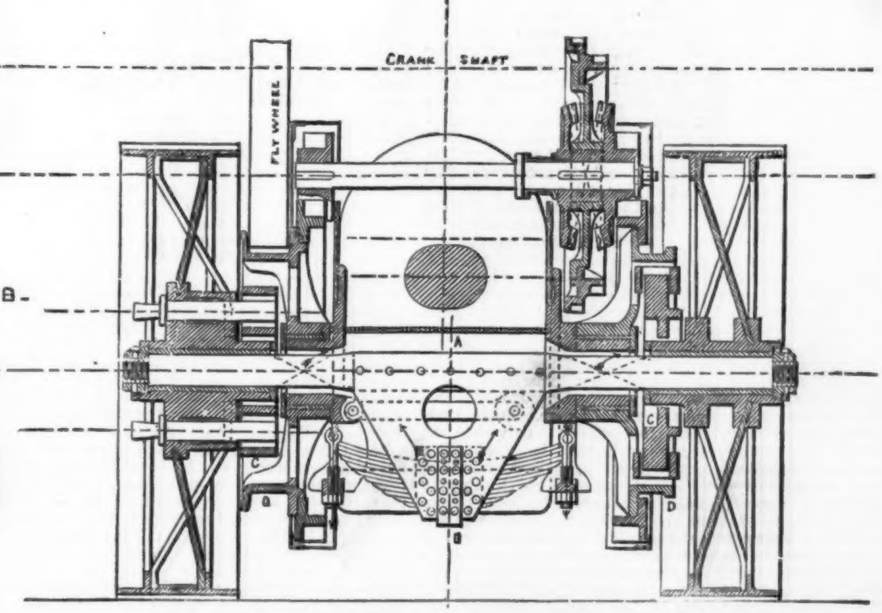






SECTION AB.





SLIDE BLOCK AND ROAD SPUR WHEEL.

SECTION THROUGH HIND AXLE AND SECOND MOTION SHAFT.

TRACTION ENGINE.—JOHN FOWLER & CO., LEEDS, ENG., ENGINEERS.

THE LEADVILLE MINES.

REMARKABLE as the mineral deposits about Leadville unquestionably are, some very grave difficulties and drawbacks seem likely to develop themselves as the work of exploration and ore reduction proceeds in that district. First, the climate, because of the great altitude, presents a serious hindrance to cheap and successful mining operations. The winters are long and bitterly cold, the snow falling early and lying for several months to a great depth. Nothing of a useful kind can be raised, for the double reason that there is no soil and that killing frosts occur every night in the year. Even the summers are disagreeable and unfavorable for outdoor work, rain falling almost every afternoon from the middle of June till the last of September. As at all great elevations in this latitude, pneumonia and other diseases of the respiratory organs are exceedingly prevalent in and around Leadville, great numbers having suffered from these complaints the past winter, a large percentage of the cases reaching a fatal termination. Neither health nor comfort can be counted upon by persons who, north of the fortieth degree, take up a residence at an altitude of 12,000 feet or more.

Then a trouble is likely to be encountered from much of the ore obtained here having too little lead to insure its successful smelting. With less than 25 per cent. of this metal for a flux it is difficult to reduce these carbonate ores by this method. While much of the ore from these mines carries a large proportion of lead, the majority carries less than 20 per cent, and cannot therefore be successfully smelted. That these ores will, with depth, grow richer in lead can hardly be hoped for, as this would run counter to past experience in this class of deposits. Everything considered, Leadville, now so crowded and bustling, does not seem likely to grow into a town of very large dimensions. When all the grounds around it shall have been taken up and there is nothing more to attract prospectors to the vicinage, or even retain those already there, its population will be diminished, only such remaining as can get work or as have secured locations requiring their presence. The number of furnaces to be erected on the spot will depend upon the quantity of self-fluxing ore these mines shall afford. If this shall turn out to be large these establishments will be numerous, and *vice versa*. In any event, a great deal of ore will be sent elsewhere for reduction, that is, if it shall be found rich enough in silver to bear cost of transportation. A careful survey of the field discloses to our view very little in these Leadville mines, that ought to greatly excite the California capitalist, speculator, or prospector.—*Mining and Sci. Press.*

RECENT SCIENCE.

[PROFESSOR HUXLEY has kindly read, and aided the Compilers and the Editor of the *Nineteenth Century* with his advice upon, the following article.]

NATURE OF THE INNER EARTH.

IT is not only to the geologist, to the physicist, and to the astronomer that speculations as to the probable nature of the interior of the earth are full of interest. So fascinating a subject appeals to a circle of inquirers far outside the pale of the special sciences. Every thoughtful man naturally feels curious to know something about the nature of the innermost parts of this earth on which we dwell. Is our globe a stony sphere, solid to its very core? Or is it made up of a hollow shell, with a mass of molten matter within? Or is there nothing but compressed gas inside the hollow sphere? Or, finally, is there a solid crust on the outside and a solid nucleus in the center, separated from each other by an intermediate layer of liquid? Each of these views, in turn, has found its advocates; and each has been supported by arguments of more or less weight. As direct observation of the earth's interior is manifestly impossible, except to a depth which is utterly insignificant in comparison with the magnitude of the earth, all reasoning on this subject must needs be based on evidence of an indirect kind. The arguments which have been advanced are drawn principally from the figure of the earth, from its mean density, from the increase of temperature which is observed on descending to accessible depths, and especially from the widely occurring phenomena of vulcanicity. A noteworthy contribution to the subject from the volcanic side has recently been made by Herr Siemens, whose investigations will be found recorded in a paper recently published in the monthly reports of the Berlin Academy.*

In seeking an explanation of the phenomena which he witnessed during a visit to Vesuvius last May, the author has been led to some general studies in vulcanology which have far more than local interest. At the time of his visit steam, or other vapor, was being ejected in explosive puffs from the cone in the center of the great crater. Sharp explosions succeeded each other at tolerably regular intervals of two or three seconds, and gave rise to rotating rings, which, widening as they rose into the air, formed a crown of vapor around the summit of the mountain. It is by no means easy to explain how such rapidly recurring explosions, with the accompanying jets of steam, could be produced. Assuming that steam or gas may be suddenly generated at great depths, it might fairly be expected that its ejection would be accompanied by the outflow of much lava; and that after each explosion sufficient time must be given for the accumulation of fresh lava in the chimney of the volcano before the next expulsion could occur. It may be suggested, indeed, that as water at a very high temperature is dissociated into its components, the magma or molten rock beneath the volcano might contain an explosive mixture of oxygen and hydrogen gases; then, on any considerable diminution of pressure, these gases would recombine and again form water. It is, however, highly improbable that, under the enormous pressure to which the magma must be subjected anything like dissociation should occur; for the author's own experiments have shown that a mixture of oxygen and hydrogen, when subjected to a very high pressure, will explode. Dismissing, then, the idea of dissociation, the author is driven to the conclusion that hydrogen gas, or it may be combustible compounds of hydrogen, rise from below, and, mingling with atmospheric oxygen, form an explosive mixture which is burnt in the upper part of the volcanic chimney. From the large quantity of steam generated by the explosions, it is probable that hydrogen is the principal combustible constituent of the gases, but it is not easy to decide whether the hydrogen exists in a free state, or combined with sulphur, carbon, and other elements. The presence of much sulphurous acid gas among the products renders it likely, however, that sulphureted hydrogen is one of the burning gases.

That water and, perhaps, hydrogen should be contained in the magma, whence the volcanic products arise, appears highly probable on the well-known nebular hypothesis. It is generally conceded that the nearest approach which has yet been made to a rational explanation of the formation of our earth is to be found in the bold hypothesis which was conceived by Kant and elaborated by Laplace. On this assumption the earth and all the other planetary bodies have resulted from the condensation of nebulæ. Thousands of these faintly luminous cloud-like bodies have been detected in the heavens, and the spectroscope has shown that some of them contain glowing hydrogen. On the condensation of a nebula, by attraction of its particles, great heat would necessarily be developed. Chemical forces would then come into play during the contraction, and such compounds would be formed as were capable of existing under the given conditions of temperature and pressure. On increase of pressure by contraction, and on reduction of heat by radiation, a liquid magma would eventually be formed. It is only from the outer portion of this molten mass, where the pressure is least, that the steam and other vapors and gases could directly escape; while at great depths they would be retained, either dissolved in the liquid mass or intimately mingled with the magma.

Against the assumption that hydrogen and other combustible gases have been retained in the magma, it will, of course, be objected that no hydrogen is found in our atmosphere; but that, on the contrary, the existence of free oxygen shows that this latter element must have been in excess when the chemical compounds were in course of formation. It must be remembered, however, that the solar atmosphere contains a large proportion of hydrogen, and that enormous volumes of this gas exist in the red flames which are shot forth from the sun. The sun evidently represents the central portion of the nebula from which the solar system took birth; and the existence of free hydrogen at the present time in this orb may suggest the former existence of an excess of this element throughout the entire system. Although oxygen now forms a large proportion of our atmosphere, this may not always have been the case. It is conceivable, indeed, that during the early stages of the earth's history the oxygen may have existed wholly in a state of combination, and may have been set free as atmospheric oxygen at a later period. But we know too little about the influence of powerful pressure and intense temperature in modifying chemical attraction, to admit of profitable speculation on such a subject.

By continued cooling of the molten globe, a separation of its components would probably occur, according to their relative weights. It is not to be supposed that the spheroid of igneous liquid would be homogeneous throughout; indeed it is possible that different parts of the same nebula may vary in constitution. Those compounds which were specifically heavier would be attracted toward the interior of the viscous sphere, while the less dense substances might remain nearer to the outside; thus the acid silicates might be separated from, and float upon, the denser basic silicates.

Whether the solidification would commence at the outside or at the center of the refrigerating globe, is a point on which many a lance has been broken. If a mass of molten metal be allowed to cool, it is well known that a crust soon forms over the surface, while the interior may remain for some time in a liquid state: this is seen equally in casting a leaden bullet and in the largest foundry work. It has, therefore, not unnaturally been argued that a crust would form on the surface of the cooling globe, and that the interior might remain in a molten condition even to the present day. It is necessary, however, to examine the arguments which have been advanced against this view.

It is now thirty years since Professor James Thomson announced on theoretical considerations, that if a body expand during solidification, its melting point must be lowered by pressure. This sagacious inference was afterward confirmed experimentally by his brother, now Sir William Thomson, who showed that the melting point of ice was lowered in the way suggested; at the same time he pointed out that if the substance contracted during solidification its melting point ought to be raised—a prediction which was confirmed by the experiments of Professor Bunsen, of Heidelberg, and of the late Mr. Hopkins, of Cambridge, whose investigations extended to such substances as wax and stearine, sulphur and spermaceti. From such experiments it has been concluded that our ordinary silicious rocks would have their melting points elevated by increase of pressure; in other words, they would require more heat to keep them in a molten state, if they were subjected to great pressure in the interior of the earth, than if they were in a state of fusion at the surface. It is clear, therefore, that in such a case, pressure and heat directly oppose each other; the former tending to prevent and the latter tending to promote fusion. Whether the rocks be solid or liquid at a given depth must consequently depend on which of these two powers gains the ascendency. Supposing that the surface of the cooling globe were locally solidified, the solid portions might be again fused as they descended to regions of higher temperature, and the globe might thus be kept in a liquid condition until it became sufficiently viscous to prevent the subsidence of the solidified portions, when a solid crust would permanently form on the exterior, inclosing a fluid mass within. But if the solidified portions, as they sank in the molten mass, had their fusing point greatly raised by the increased pressure to which they were subjected in their deeper-seated position, then it is possible that they might retain their solid condition even at the very center of the globe. In this event the process of solidification would begin at the center, and gradually tend outward, until a solid, or nearly solid, spheroid was ultimately produced.

It will be observed that this discussion hinges on the question whether the molten rock would contract on solidification, and, if so, to what extent. Sir William Thomson based his calculations on the experiments of Bischof, which went to show that solid rocks are about 20 per cent. denser than the same material in a molten state. Mr. Mallet's experiments on blast-furnace slags show, however, that these silicates contract only to about 6 per cent. during solidification. Herr Siemens seeks to explain the difference between these results by an appeal to some interesting experiments conducted by his brother, Friedrich Siemens, at his bottle glass works in Dresden. He found that if the glass be perfectly fused to a thin liquid and be then allowed to cool, it rapidly contracts until it acquires a plastic or viscous condition; but on further cooling of this viscous material, the contraction is greatly diminished; and as the temperature continues to fall, the amount of contraction becomes less and less. In fact, at the very moment of solidification, it is likely that a slight expansion occurs. It appears, therefore, that when such a liquid as a molten vitreous silicate acquires solidity, the greater part of the observed contraction occurs during the transition to the plastic state. Hence the author argues that Sir W. Thomson's calculations based on Bischof's experiments are inadmissible, and that they go to prove, not that the earth must in consequence of pressure be solid to its center, but simply that the interior has become plastic or viscous.

According to Sir W. Thomson's views, volcanoes must be fed from local accumulations of lava, probably from pockets of liquefied or partially liquefied matter which exist here and there at varying depths beneath the surface. Herr Siemens insists on the mechanical difficulty of explaining how, under such conditions, the lava could be forced upward to the surface. He also exposes the geological difficulty of accounting, on the hypothesis of a solid globe, for the formation of the many thousand feet of alternating sedimentary deposits which are spread over the surface of the earth. On these and on other grounds, the author is led to reject the assumption of a solid or nearly solid earth, and to fall back on the hypothesis of a liquid or a viscous mass inclosed in a crust of moderate thickness. To explain the ascent of lava from the interior of the earth to the crater of a volcano, it is assumed that the highly fusible alkaline and hydrous lavas have a density which is below that of the solid crust or of the viscous silicates with which they are associated. These lighter silicates find their way into narrow ramifying channels or other cavities in the earth's crust; and when communication is established between these cavities and the surface, a column of liquid lava is forced up the canal by hydrostatic pressure. The force with which the lava rises in the pipe will be much increased by the expulsion of steam and various gases which are associated with the molten material, and are released from this association by diminution of pressure. Whether the lava is poured out at the surface or not will depend on the quantity of molten matter which rises in the chimney, on its specific gravity, on the proportion of gas and of water which it contains, and especially on the altitude of the volcano. Many very lofty volcanoes eject no liquid lava, since hydrostatic equilibrium is secured before the column rises into the crater. On this principle, too, it may possibly be explained why most active volcanoes are situated either in or near to the sea.

In concluding this paper Herr Siemens briefly refers to the necessity of making another assumption in order to explain, on the hypothesis of a liquid sphere with a comparatively thin crust, the great elevation of many continental areas and the gradual upheaval of large tracts of country at the present day. The difference in height between the plateau of Central Asia and the bottom of the Pacific Ocean is at least 12,000 meters, representing a difference of pressure on the magma of about one thousand atmospheres. In order to attain, under such conditions, the requisite hydrostatic equilibrium, it seems necessary to assume a difference of density between the rocks which constitute the continents and those which form the floor of the ocean, the latter being, of course, the denser. It is possible, however, that the semi-fluid masses which occur below the solid crust have such a thickness and such a density as to compensate for this difference of pressure. Secular elevation would then follow as a local consequence of such difference.

In connection with this subject it may be pointed out that in measuring the great Indian arc of the meridian, which stretches from Cape Comorin to the Himalayas, it was found that the density of the rocks under and in the neighborhood of the Himalayas is less than in the plains to the south. A mass of matter like that of a mountain will, of course, exert an attractive action upon the plumb line, and will tend to pull it out of the perpendicular. Archdeacon Pratt calculated the extent of this deflection in the case of the Himalayas, but observation showed that the actual deviation was very much less than his computation; thus suggesting that the matter in these mountains, or in their neighborhood, has a lower density than that of the rocks of the plains. It has also been found in geodesical surveys that gravity at coast stations is generally greater than at the corresponding continental stations. Indeed, Archdeacon Pratt remarks, in his "Figure of the Earth," that "the density of the crust beneath the mountains must be less than that below the plains, and still less than that below the ocean bed."

It is also interesting to note that the Astronomer Royal, in delivering a popular lecture last year at Cockermouth, expressed himself in similar terms: "If one might presume on such a point, I should say that the high parts of the earth are made of something light. The heavy dense parts are those covered by considerable quantities of water, and they have sunk deep into the center of lava in which I conceive all things to be resting."* In this lecture Sir George Airy adds the great weight of his authority to the view that the center of the earth is still, to a great extent, in a condition of igneous fluidity. "I do think," he says, "that a large proportion of the central part of the earth is fluid and hot, and I think that upon this there are resting divers classes of something like solid matter."

From what has been advanced in the preceding pages it will have been gathered that the present tendency among most men of science seems in the direction of a return to the old-fashioned views according to which the earth has a moderately thin crust which rests on a spheroid of molten matter in a more or less viscous condition.†

THE MOLECULAR CONSTITUTION OF MATTER.

It is a great stride to descend from speculations on the nature of the interior of the earth to speculations on the molecular constitution of matter. But the remarkable researches which Mr. Crookes has recently submitted to the Royal Society deserve the earliest possible notice, since they open up a new field of scientific inquiry which has already led to unexpected results.‡

On the passage of a spark from an induction coil through a highly rarefied gas, such as that in a common vacuum tube, a dark space is observed around the negative pole. It would appear that the intense molecular vibration set up in the metal forming this pole excites a molecular disturbance in the surrounding medium, and in the case of a highly attenuated gas the area of disturbance may extend to a considerable distance from the electrified surface. By connecting an ingeniously constructed radiometer with the inductorium, in such a way as to make the movable fly play the part of the negative pole, it was found that, on exhausting

* "Physikalisch-mechanische Betrachtungen, veranlasst durch eine Beobachtung der Thätigkeit der Vesuvs im Mai 1878." *Monatsbericht der k. preussischen Akademie der Wissenschaften zu Berlin*, 1878, pp. 558-582.

* "On the Probable Condition of the Interior of the Earth." By Sir George Airy, K.C.B., F.R.S., etc. "Transactions of the Cumberland Association for the Advancement of Literature and Science." Edited by J. Clifton Ward. Part III., 1878, p. 48.

† On this subject attention may be called to a valuable paper by the Rev. Osmond Fisher, "On the Inequalities of the Earth's Surface as produced by Lateral Pressure upon the Hypothesis of a Liquid Substratum," "Cambridge Phil. Trans.," vol. xii. part ii.; to Capt. Dutton's "Critical Observations on Theories of the Earth's Physical Evolution," the *Penn Monthly*, Philadelphia, May and June, 1876; *Geol. Mag.*, 1876, pp. 322, 370; and to a paper by the late Mr. David Forbes in the *Geol. Mag.*, October, 1867.

‡ "On the Illumination of Lines of Molecular Pressure, and the Trajectory of Molecules." By William Crookes, F.R.S., etc. "Proceedings of the Royal Society," vol. xxviii., No. 191, p. 103.

the vessel, the metallic faces of the vanes became enveloped in a halo of velvety violet light, while the opposite sides of the vanes remained obscure. As the pressure was reduced by continued exhaustion, the luminosity became separated from the metal by a dark space; and on continuing to exhaust, this dark space extended to the glass walls of the vessel, against which it appeared to become flattened, the rotation of the fly meanwhile being very rapid.

In order to understand the principle on which Mr. Crookes seeks to explain these phenomena, it is necessary to refer briefly to the modern view of the constitution of gases known as the kinetic theory. According to this theory any given volume of gas contains a vast number of molecules, or material particles, moving in all directions with astounding rapidity, and therefore coming at every instant into contact with one another. Between successive encounters the molecule is supposed to move in a rectilinear path; but as the collisions succeed each other with great rapidity, probably numbering millions in a second, the free path must, as a rule, be excessively small. During rarefaction the number of particles in the given space is, of course, reduced, and, therefore, the chances of collision are lessened. At a very high degree of exhaustion, such as obtains in these vacuum-tubes, the space is so little crowded that the molecular encounters are comparatively few, and the mean free path is therefore larger.

According to Mr. Crookes' view, the electrified molecules of the residual medium in the tube rebound with great velocity from the negative pole, and in this way keep back the more slowly moving molecules which are advancing toward that pole. At the border of the dark space collisions occur, and the arrest of velocity gives rise to luminous effects. It is obvious, therefore, that the thickness of the dark space around the pole may be taken as the measure of the length of the free path between successive hits. By continued exhaustion the length of path may be made to exceed the distance between the fly of the electric radiometer and the sides of the glass vessel which incloses the instrument. There will consequently then be no luminosity produced until the molecules impinge against the glass, whereby their energy is suddenly checked. It is found that when the molecular rays are brought to a focus, in a tube at a high degree of exhaustion, the particles on impact with the glass develop a beautiful phosphorescence. A soft German glass, which was chiefly used in Mr. Crookes' experiments, gave a fine greenish-yellow light. This phosphorescent light is to be distinguished from the ordinary luminosity observed in vacuum tubes; such tubes give, for example, different spectra according to the nature of the residual gas, while the phosphorescence in these highly rarefied media gives a continuous spectrum of the same kind, whatever be the nature of the gas.

Further experiments led to the interesting discovery that the stream of molecules from the electrified surface is highly sensitive to magnetic influence, and may be deflected in one direction or another by means of a magnet. The rays which pass from the negatively electrified body to the glass surface are spoken of by the author as "rays of molecular light" or "rays of emissive light." These "rays," however, are simply streams of molecules passing from the excited body, which are invisible until, falling upon a suitable screen, their effects are manifested by the luminosity of this screen. A bullet which strikes a target may become red-hot; but the trajectory of the bullet could not, on that ground, be properly called a "ray" of light or heat.

It is conceivable that, at the very high degree of exhaustion attained in these tubes, the mean free path of the rapidly moving molecules may become so long that "the hits in a given time may be disregarded in comparison to the misses." In one experiment it was found that a number of molecules sufficient to excite the green phosphorescence had been projected to a distance of 102 millimeters without being stopped by collision. In highly rarefied media the properties which are peculiar to gases must, therefore, be reduced to a minimum, and it is even conjectured that the media may pass into an ultra-gaseous state in which new properties come into play. To borrow Mr. Crookes' concluding words: "The phenomena in these exhausted tubes reveal to physical science a new world—a world where matter exists in a fourth state, where the corpuscular theory of light holds good, and where light does not always move in a straight line, but where we can never enter, and in which we must be content to observe and experiment from the outside."

(*To be continued.*)

FOSSIL FORESTS OF THE VOLCANIC TERTIARY FORMATIONS OF THE YELLOWSTONE NATIONAL PARK.*

By W. H. HOLMES.

THE prevalence of extraordinary volcanic activity throughout that part of the Tertiary age represented by the post-Cretaceous rocks of the Yellowstone region has given to them a most unique and interesting character. So destitute of animal remains are they, and so unlike the formations of the age in other parts of the Rocky Mountain region, that, notwithstanding the frequent visits of geologists, no divisions into sub-groups have been made, and no more definite appellation for the whole group has been found than the "Volcanic Tertiary;" this name, although so general, is singularly appropriate, and in the absence of specific determinations, may be used to designate the entire group of Tertiary strata in the Park district.

It is not my intention in this brief notice to attempt the classification and correlation of these strata, but to give a brief account of some very remarkable features brought to light by last year's explorations.

In the valley of the East Fork of the Yellowstone River, where this peculiar group of rocks is typically developed, they have a thickness of upwards of 5,000 feet. The prevailing materials which enter into their composition are fragmentary volcanic products, which have been apparently redistributed by water, and now form breccias, conglomerates, and sandstones. It has been noticed by nearly all visitors that these strata contain a great abundance of silicified wood, and in a few cases trunks of trees *in situ* have been reported. The lowest observed occurrence of the strata of this group is in the valley of the main Yellowstone, between the first and second cañons, at an elevation of nearly 5,000 feet above the sea. They are also finely developed in the Gallatin Range to the west of this valley, and about the sources of Cañon and Bowlder Creeks reach a thickness between 3,000 and 4,000 feet. At a number of points covering this entire thickness, masses of silicified wood occur, and near the divide at the head of Bowlder Creek silicified trunks, many feet in height, and of gigantic proportions, stand in the identical strata in which they grew, the crumbling conglomerates having withered away, leaving them standing upright along the steep slopes of the mountain. In general, these strata are horizontal. The bedding is often heavy, and in places not well marked; sub-aerial volcanic deposits apparently alternate to some extent with the sub-aqueous.

Three miles above the mouth of Gardiner's River, in similar strata, there are a number of silicified trunks *in situ*, most of which occur in a stratum of sandstone that lies directly upon the eroded surface of a series of mica-schists that belong to the metamorphic range north of the Yellowstone River. This is at an elevation of 6,000 feet.

On the south side of the third cañon, opposite the mouth of Hell Roaring Creek, is a massive promontory composed of conglomerates, in which are very numerous intercalated beds of sandstone and shales. In the steeper faces of this promontory many fine trunks are exposed. In 1872 Dr. Peale obtained some very perfect specimens of fossil leaves from these beds, on the Elk Creek side, which were determined by Professor Lesquereux to be of Eocene types. The walls of the cañon in the vicinity of Hell Roaring Creek are formed of the same series of rocks, which occur also at a number of points on the river between Elk Creek and the lower falls.

In the valley of the East Fork, the sedimentary formations of the Volcanic Tertiary reach their maximum development. Here they rest upon the unevenly eroded surfaces of the palæozoic and granite rocks, and form a great part of the mountain ranges that inclose the valley. They are horizontal and apparently conformable throughout the entire thickness of 5,500 feet. The greater part of this immense group of strata is filled with the silicified remains of a multitude of forests.

The section given in the accompanying plate occurs in the north face of Amethyst Mountain, opposite the valley of Soda Butte Creek, and includes upwards of 2,000 feet of strata. The bed of the river is at an elevation of 6,700 feet above the sea, and the summit of Amethyst Mountain, 9,400. On the north side of the valley, near the mouth of the Soda Butte Creek, there are between 300 and 400 feet of carboniferous strata exposed along the base of the mountain slope. On the south side occasional ledges of limestone appear above the detrital deposits. Thin sheets of basalt cover the flat part of the valley, which is here less than a mile in width.

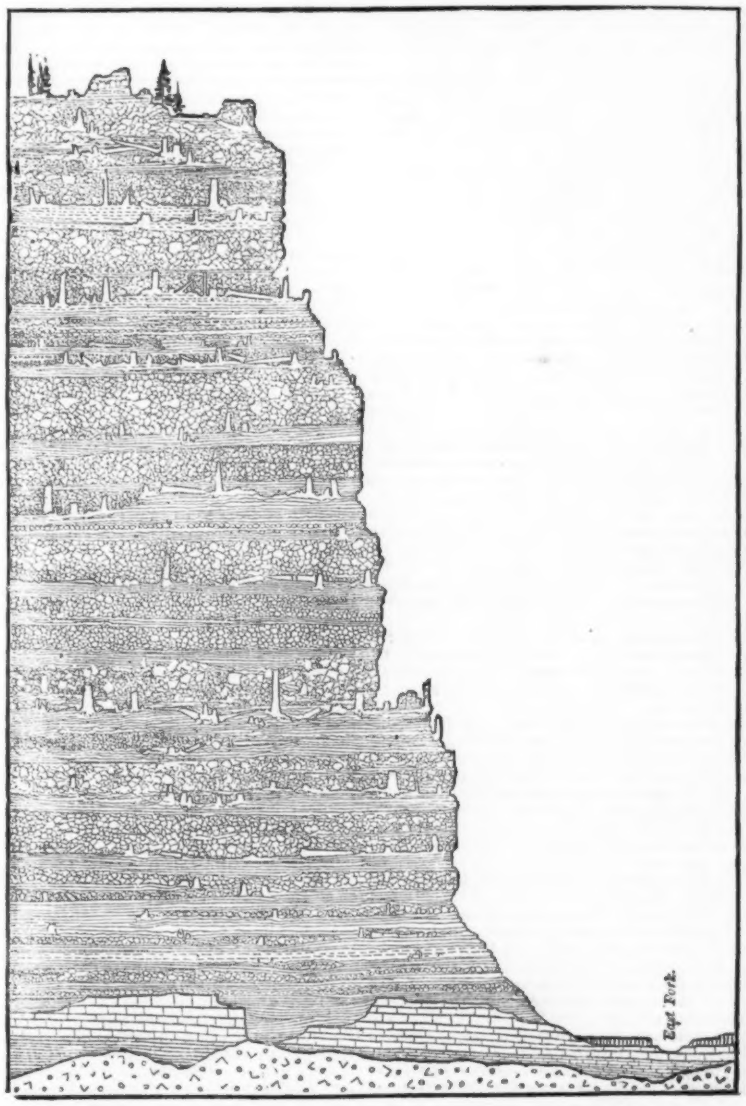
The north face of Amethyst Mountain does not present as abrupt a profile as that given in the section, the middle part only being so precipitous. At the base and top there are comparatively gentle slopes; nevertheless, the actual stratigraphical conditions are truthfully represented.

As we ride up the trail that meanders the smooth river-bottom, we have but to turn our attention to the cliffs on the right hand to discover a multitude of the bleached trunks of the ancient forests. In the steeper middle portion of the mountain face, rows of upright trunks stand out on the ledges like the columns of a ruined temple. On the more gentle slopes farther down, but where it is still too steep to support vegetation, save a few pines, the petrified trunks fairly cover the surface, and were at first supposed by us to be the shattered remains of a recent forest.

In ascending one of the steep spurs that project from the main wall, the strata were found to consist, toward the base, of shales and fine-grained sandstones. Higher up conglomerates occur, and still higher coarse conglomerates and breccias prevail. Interbedded with the massive, irregular beds of the latter rocks are always thin layers of sandstones and shales. The sandstones are fine-grained, thinly bedded, and contain more or less tufaceous material. Their prevailing color is greenish and greenish-gray. They are apparently composed chiefly of materials derived directly or indirectly from volcanic sources. In no case are pebbles of quartz or other granitic constituents found in either the sandstones or conglomerates.

The exposures of strata in the first three or four hundred feet at the base are not good, and but few of the silicified trunks appear above the covering of vegetation. At the height of 500 feet, the occurrences become very numerous, and the great size and fine state of preservation of many of the trunks were a matter of much surprise. Prostrate trunks, fifty and sixty feet in length, are of frequent occurrence, and not a few of these are as much as five or six feet in diameter.

The standing trunks are generally rather short, the degradation of the compact inclosing strata being so low that the brittle trunks break down almost as fast as they are exposed. In many cases the roots are exposed, and may be seen penetrating the now solid rock with all the original ramifications. One upright trunk, of gigantic proportions, rises from the inclosing strata to the height of twelve feet. By careful measurement it was found to be ten feet in diameter, and as there is nothing to indicate to what part of the tree the exposed section belongs, the roots may be far below the surface, and we are free to imagine that there is buried here a worthy predecessor of the giant *Sequoias* of California. Although the trunk is hollow, and partly broken down on one side, the woody structure is perfectly preserved, the grain is straight, and the circles of growth distinctly marked. The bark, which still remains on the firmer parts, is four inches thick, and retains perfectly the original deeply lined outer surface. Specimens of the wood and bark were collected, but no microscopic examinations have been made. It is clear, however, that the tree was not a conifer. The strata which inclose this trunk are chiefly fine-grained greenish sandstones, indurated clays, and moderately coarse conglomerates. They have been built around it as it stood in comparatively shallow but doubtless quiet waters. As would naturally be expected these strata contain many vegetable remains: branches, rootlets, fruits, and leaves are extensively inclosed. One stratum of sandstone that occupies a horizon nearly on a level with the present top of the giant tree contains a great variety of the most perfectly preserved leaves. Such specimens as we were able to bring away with us have been submitted to Professor Leo Lesquereux for identification. They are found by him to belong to the



THE FOSSIL FORESTS OF THE YELLOWSTONE.

* From the Bulletin of the U. S. Geological and Geographical Survey.

Lower Pliocene or Upper Miocene, and correspond in a number of their species with the Chalk Bluffs specimens of Professor Whitney. They include *Aralia Whitneyi*, *Magnolia lanceolata*, *Laurus canariensis*, *Tilia* (new sp.), *Fraxinus* (new sp.), *Diospyrus* (new sp.), *Cornus* (new sp.), *Pterus* (new sp.), *Alnus* (new sp.), and a fern (new sp.).

It will be observed that most of these species are new, which was also the case with the collection of Professor Whitney. It is also worthy of remark that none of the genera are identical with those of the Elk Creek locality previously mentioned. The stratigraphical relations of the two localities cannot easily be made out, as they are separated by fifteen miles of broken country, in which the strata are obscured by igneous flows and Quaternary drift. The Elk Creek strata are lower by fully one thousand feet.

As far above the leaf bearing horizon as I was able to ascend, the silicified trunks were very numerous and well preserved, and, by the aid of a field-glass, others could be detected in all parts of the cliff to the highest stratum.

At another point, nearly a mile farther east, I climbed the rugged walls of the mountain for the purpose of examining a number of large trees that were visible from below. Trunks and fragments of trunks were found in great numbers and in all conceivable positions. In most cases the woody structure is well preserved, the trunks have a tendency to break in sections, and on the exposed ends the lines of growth, from center to circumference, can be counted with ease. In many cases the wood is quite completely opalized or agatized, and such cavities as existed in the decayed trunks are filled with beautiful crystals of quartz and calcite. Our party was so fortunate as to secure some very handsome specimens of amethyst and ferruginous quartz. It is a matter worthy of observation that nearly all of the beautiful crystals that occur so plentifully in this region have been formed in the hollows of silicified trees. The same fact has been noticed in regard to similar crystals in many parts of the West, and notably in the case of the smoky quartz of the Pike's Peak region in Colorado.

The silicifying agents have been so unusually active in the strata of the Volcanic Tertiary that not only are all organic remains thoroughly silicified, but all cavities in the loosely bedded rocks and all fracture-lines in the strata are filled with chalcedony or other forms of quartz.

On reaching the heavily bedded conglomerates of the upper third of the cliff, I found the trees still more perfectly preserved. Many of the trunks are twenty and thirty feet in height. Their roots are in most cases embedded in the layers of finer-grained materials, in which they grew, while the battered and branchless trunks are encased in the coarse conglomerates and breccias. These latter rocks are composed chiefly of basaltic fragments, many of which are of great size; there is, however, always enough tufaceous and other fine-grained material to fill in the interstices and act as a cement. These beds are massive and irregular, and seem to have accumulated too fast to be thoroughly redistributed by the waters. Only the stronger trees of the forest seem to have withstood the fierce storms of rocks that must have prevailed at the period of their entombment, as the smaller trunks and branches are prostrate or totally destroyed. In most cases where upright trunks penetrate the entire thickness of an inclosing bed, the tops may be seen to terminate with the upper surface of that bed, as if causes had acted at the beginning of the deposition of the succeeding stratum to plane down the irregularities of the old surface. In due course of time this succeeding stratum produced its growth of forest, which followed its many predecessors into the subterranean depths, and in its turn was buried by the rapidly accumulating conglomerates. This remarkable alternation of events seems, in a general way, to have been kept up from the beginning to the end of the period.

The very precipitous character of the cliffs prevented me from reaching the upper part of the wall at this point, but I succeeded in making my way to the summit of the mountain at two other points, and found that everywhere the section was practically the same.

On the opposite side of the valley the same conditions were observed: the fossil trees occur at the highest point reached, 3,000 feet above the river. The ranges that form the rim of this valley on the north and east reach an elevation of 11,500 feet, and as the conglomerates may be seen reaching and forming the loftiest summits without perceptible break or change of character, it is probable that they will be found to inclose the remains of forests throughout.

On some of the higher summits to the east of Yellowstone Lake, similar stratified conglomerates contain silicified wood in a very fragmentary state These conglomerates are composed mainly of basaltic and trachytic materials, but contain large quantities of fragments of sandstones and quartzites, which leads to the conclusion that portions of the earlier Tertiary strata have been broken up and ejected with the igneous products. It is quite probable that these strata were among the later products of the Volcanic Tertiary age proper. They are generally found abutting against masses of unstratified igneous materials that probably mark the sites of islands which were doubtless volcanic centers. I find that as we recede from these centers of eruption the strata diminish very perceptibly in thickness and coarseness of materials, and have at the same time a very perceptible dip toward the surrounding valleys. One is at times led to suspect that portions, at least, of these beds are of sub-aerial formation, as is the case with extensive strata about the cones of modern volcanoes, but there are a multitude of facts that go to prove that the greater part of the formations of this age were rearranged or sedimented in water.

As to the character of the seas or lakes in which the Volcanic Tertiary beds were laid down, it is clear that their waters were fresh, but as to their extent or distribution little is known. The formations cover or have covered an area of not less than 10,000 square miles, but they lie at a much greater elevation above the sea than the formations of synchronous lakes of neighboring provinces, and so far as is known, have no actual connection with them.

It has been suggested by some one that these coarse volcanic strata may have been formed in very restricted bodies of water held high amongst the mountain ranges; but lakes cannot exist without barriers, and as has already been shown, the conglomerates, although naturally disintegrating more rapidly than any of the older rocks, now form the summits of many of the highest peaks that face the eastern plains, and the basins in which they were formed must have had free communication with the lowlands to the west, from the beginning to the end of the period.

For my present purpose it is sufficient to know that the bodies of water of this period were of sufficient extent not to be greatly affected in level by the filling-in of volcanic products or by the oscillations of the district under discussion, since we can have no correct measure of those oscillations of the surface which define the thickness and decide the character of strata without the barometer-like records of a sea-level.

The change of level produced by the great oscillation that preceded the Volcanic Tertiary period, and brought the lofty ranges of this region into existence, cannot fall far short of 20,000 feet. In order to reach these figures, we have but to add to the full thickness of the palæozoic and mesozoic strata the present elevation of the granitic ranges above the lowest observed stratum of the Tertiary rocks. At the beginning of the deposition of the Volcanic Tertiary rocks, however, the upward movement had ceased. The land had undergone enormous erosion, and subsidence had commenced. The great ranges that had lifted their crests to such lofty heights were again sinking beneath the sea. This subsidence did not cease until all, or nearly all, of the mountain peaks were submerged. It is in the strata deposited during this great subsidence that we must look for evidences of conditions and of events that made the entombment and preservation of a vertical mile of forests possible.

The Yellowstone Valley, from the head of East Fork to the Lower Cañon, is carved out of strata which were formed along the west and south bases of the main eastern range of mountains. In many places the river has penetrated the full thickness of Tertiary strata, and has cut down into bodies of metamorphic rocks that at the beginning of the age were promontories or islands. It is plain, therefore, that those parts of the tree-bearing strata examined, were deposited along a shore-line, or, at least, near the borders of the Tertiary lake. Over large districts there must have been, during the period of general subsidence, a frequent alternation of land and sea. Land would have to exist while the forests grew and matured; water would have to cover the same area to deposit the succeeding stratum; and again this stratum would have to rise above the water before a second forest could grow. There are two ways in which this result could be brought about. In a district subject to such intense volcanic action as this must have been, a succession of minor oscillations might have been associated with the general subsidence, so that large areas of the lake border districts would be alternately above and beneath the sea, or, as was doubtless often the case, the shallow portions of the sea became filled up with the rapidly accumulating ejecta, and sub-aerial deposits of sufficient depth were laid down to allow the growth of forests, which, in time, were depressed by the general subsidence, to be buried by a succeeding stratum of the volcanic débris. But this latter method was not the ordinary one, as is attested by the fact that many of the forests have grown in beds of fine-grained material that must have been formed beneath the surface of the water.

I shall, however, not attempt to pursue this matter further until all the data and materials collected have been examined. A thorough study of the various volcanic rocks will probably throw much light upon this very interesting group of strata.

A SALT MOUNTAIN IN ST. DOMINGO.

EUROPE has its subterranean salt mines, of which the saline springs were, until lately, used by gradually evaporating the brine pumped over brushwood, where a strong current of air contributed to its evaporation until it became sufficiently strong for the salt-pans. A brine containing only one fifth per cent. of salt was thus concentrated to a strength of from 15 to 18 per cent. This brine was rapidly evaporated by artificial heat, a considerable deposit of sulphate of soda being formed, which was from time to time removed, leaving the crystallized salt behind. This process of brush evaporation has been entirely abandoned since the discovery of solid salt deposits by boring at comparatively easy depths. Saxony, the Salzkammergut in Austria, and Wieliczka, the South of France, Droitwitch and Chester in England, yield immense quantities of rock-salt, but nowhere in the world have the convulsions of the earth thrown out such enormous masses as in the island of St. Domingo. Here a mountain more than nine miles in length, and from one-half to three-quarters of a mile in width, of a height of from 100 to 700 feet, is composed of solid layers of salt, nearly pure and ready for use. The inhabitants have used this for hundreds of years, and though Humboldt mentioned this phenomenon at the commencement of this century, though many other explorers, notably Sir Robert Schomburgh, have spoken about the commercial value of this heap of condiment, no serious efforts have been made until lately to turn this source of profit to account. That this neglect has continued during the last decade is perhaps to be attributed to the unfortunate speculation with which the name of St. Domingo has been coupled. Lately a company has been formed in this country to work these mines in connection with American capitalists, for which the Dominican Government has granted concessions. The quantity of salt in sight is reported to be inexhaustible, and the labor necessary to extract it is that of simple quarrying. This mountain is about 15 miles distant from the town of Barahona on the Bay of Neyba, where vessels of the largest tonnage can find safe shelter and anchorage near the shore. A railway to connect this port with the mine is contracted for, and the necessary jetties will soon be commenced. This enterprise is of great value to the fishermen of Nova Scotia and Newfoundland, as it must naturally furnish them with cheaper salt than is obtained from the sources whence they have received it heretofore. The great market, however, open to this enterprise must be the United States, consuming as they do a total of over 1,300,000 tons annually, of which about one-half is imported from abroad, principally from Liverpool, but also from Turk's island in the Bahamas, Hyères in France, Trapani in Sicily, Cadiz in Spain, and Curaçao in the Dutch West Indies. According to the New England illustrated newspaper, called *Industry*, later surveys and reports by Mr. Ruschhaupt, civil and mining engineer, and by Mr. Brandner, C.E., fully confirm the opinions which have been formed.

A MOUNTAIN SINKING.

IT is not uncommon in the Gulf and Southeastern Atlantic States for large bodies of land to sink below their original levels, but such phenomena have generally occurred in the low and sandy countries. The Toccoa (Georgia) *Herald*, however, reports the subsidence of a whole mountain in that country which is composed of, at least, half rock. A heavy storm was felt on the 20th of March, accompanied by thunder and lightning and a terrible shaking of the ground. Immediately following this, it was found that the whole north side of Chattoogo mountain, sloping down at an angle of 45 degrees to the Chattoogo river and 1,200 feet in height, was gradually sinking. There was a break near the top, and at one point, over the top of a sloping ridge, a perpendicular rock showed itself, the depth of which was about 16 feet and the extent 30 or 40 acres. The bank was in the form of a horseshoe, the toe being at the top of the mountain. Trees were standing with their roots up, and large stones cast out upon the surface. About three years ago an earthquake cracked the mountain at the point where the present break occurred, but no notice was taken of it at the time. Some fear is manifested by the inhabitants as to the results of this subsidence and the depth to which it may extend.

THE BRAZILIAN SANDSTONE REEFS.

As a result of his careful study of the Pernambuco reef, and of many others of similar character, some of which we will mention further on, Prof. Hartt has given us the following conclusions regarding the mode of information of this class of structures.

It is very evident that they are not the out-cropping edges of beds of sandstone, extending out from the shore, as some have supposed, but only narrow strips of stone of light thickness, formed in exactly the same position in which we see them to-day, that is, just below the level of high tide. They have resulted from the solidification of beach materials, or sea beaches, by carbonate of lime carried into them by the percolating waters. This action goes on from the level of mean high tide to a variable, but only slight, distance below low tide mark, and has only a limited horizontal extension. By the after encroachment of the sea, aided by rivers flowing behind them, these consolidated beaches have often been separated from the main shore as distinct reefs; but sometimes this latter action has not taken place, and the hardened layer retains its normal position upon the beach.

The agencies concerned in the formation of these hardened beach deposits are mostly very simple ones, many of which can be witnessed by any person visiting the sea shore. The slope of a sand beach varies according to the size and character of the sand grains composing it, the exposure of the coast and the height of the tides. When a wave strikes upon a beach it rushes upon the slope in a sheet of foam, carrying with it a quantity of sand. As it returns the sand is spread out over the surface in a thin layer. In this manner a regular lamination, dipping at a more or less even angle, is produced in the material composing the beach. But this regularity is often much disturbed by storms, when the beach may be broken into by the waves and much of its material redeposited at quite different angles.

If the land back of the shore be very low, the beach may form a simple narrow ridge, over which the waves completely break at high water, carrying and depositing sand on the inner side of the beach, where the dip of the laminæ will of course be landward. Ordinarily, however, a ridge of sand is formed behind the sea beach, above the reach of the tides, being partly due to the action of the surf during storms, but mostly to the winds. Such a beach ridge as this accompanies most of the Brazilian beaches, which latter, on account of the exposed character of the coast, are formed of quite clean sand, consisting mainly of rounded silicious grains, with broken or perfect shells and finer calcareous particles, derived from shells, corals, stony sea-weeds, etc.

The action of the tides is not limited to the surface of the beach, but this, from its porous character, absorbs a certain amount of the water. At low tide the beach just below high tide level is wet but not soaked with water; going downwards, however, we find the beach becoming gradually wetter and wetter until it is completely saturated, producing little rills which run down the surface. With the rise of the tide the level of complete saturation also rises, and when the tide is high the upper part of the beach, for some distance above high tide mark, is completely charged with water thrown upon it by the waves. A constant movement of water is thus produced in the interior of a beach, but on account of the friction against the grains of sand, this movement can only extend over a comparatively slight width, at least in the upper portions of the beach, which are under the water for only a few hours each day.

Now sea water, in many parts of the world, and especially within the tropics, is very highly impregnated with bicarbonate of lime, and this solution, from evaporation or other causes, may deposit its lime in the form of a carbonate, which acts as a cement. Where evaporation goes on over a beach wet with sea water of this character, the surface materials may become consolidated, as occurs at the Abrolhos islands, on the coast of Brazil, and elsewhere. Not only, however, may the upper sands be soldered together, but the hardening may even go on below the level of the sea.

On the Brazilian coast, the surfaces of the beaches are seldom hardened during the ebbing of the tide; but under the hot tropical sun and strong prevailing winds, there must be, in the upper part of the beaches, a concentration of the calcareous solution, which, on sinking downwards to the level of complete saturation, tends to deposit its carbonate of lime as a cement, uniting the grains of sand. The water from rains, percolating through the beaches, may also bring lime, arising from the dissolving of shells and corals in the upper layers, and lagoons, which frequently lie back of the beach ridge, may contribute to the same result.

It is evident, however, that the work is mostly done by the sea water, and that this agent, under certain conditions, has the power of solidifying sea beaches to a variable distance inland, and to a depth varying from about high tide level to a few feet below low tide level

If a beach be growing rapidly, or if it is being rapidly worn away, solidification cannot take place, because it is only over a stationary shore, that is neither receiving new accumulations of sand nor parting with its old, that time is granted for the accomplishment of this result. Therefore, consolidated beaches must be the exception and not the rule on the Brazilian coast, where the shore is undergoing much change nearly everywhere, and as sandstone reefs seem to be confined to that single country, it must be that there alone are the proper conditions attained for their formation. The hardening appears to extend from the outer side of the beach inwards, and from below upwards, as new reefs usually lie on the lower and outer part of the beach; the younger reefs are also softer in texture than the older, more finished ones.

It is probable that many of the ordinary Brazilian beaches are solidified below the surface, but until something happens to uncover them, it is impossible to determine the fact. Reefs in process of formation are to be seen on the coasts of both Pernambuco and Bahia, and at Porto Seguro; in the latter province, there is a double reef, the outer one being the wreck of an unfinished structure, the inner still undergoing solidification.

Prof. Hartt was led to believe, from his earlier studies of the Brazilian stone reefs, that a slight elevation of the land was necessary to account for their present position; but his later studies proved to him that such a hypothesis was wholly uncalled for, and that none of the reefs reach above

high tide level, or at the most above the level to which a beach is saturated with water at high tide.

Statements have been published that a certain amount of upheaval must have occurred to produce the supposed strong seaward dip of the laminæ of the sandstone; but nowhere, excepting on edges where blocks have been undermined and tilted up, is the inclination greater than might obtain on a sand beach. To suppose an upheaval to have effected these narrow lines of reef, tilting the strata evenly in one direction, and no part of the neighboring coast, is a geological absurdity. The reefs follow the general trend of the shore, and are more or less curved, but generally straighter than the beaches immediately back of them.

Having shown that the curious reefs at Pernambuco, which for many years was a complete puzzle to explorers, has been formed through the agency of very simple forces, in part working upon every sand-beach in the world, we will hastily glance at the other evidences of the same phenomenon on the Brazilian coast.

The northernmost consolidated beach examined by the Geological Commission is near the mouth of the Rio Parahyba do Norte, where, to the south of a fringing coral reef, there are traces of a short and imperfect stone reef lying upon the shore. Stone reefs have, however, been recorded from north of this point by other observers, but they have never been described; one is situated at the mouth of a small river, about eighteen miles north of the Parahyba do Norte, and another lies in front of the Rio Potengy, in the province of Rio Grande do Norte.

Directly to the south of Cape Sto. Agostinho, in Pernambuco, is the most perfect stone reef discovered. It is almost absolutely straight, its northern end being separated from the cape by only a narrow break or bar, encumbered by loose blocks of reef rock. The land back of the reef, being very low, has been swept deeply away, forming a broad and very shallow bay. The inner edge of the reef is honeycombed and as irregular as that of a coral reef, while the shallow basins of the median and inner portions of the surface are much developed, forming regularly terraced plateaux.

At Rio Formoso, in the same province, there is another stone reef, reaching only about three feet above mean low tide, and not having a great length. The joints dividing the reef rock are often filled in with sand, which has sometimes been solidified. On the island of Santo Aleixo, not far distant from Rio Formoso, is a small reef of soft texture, lying alongside the beach, and other imperfect reefs also occur in this vicinity on the main shore.

Nowhere near the city of Bahia do we find perfect sandstone reefs; but at the mouth of the bay of Bahia, close to the lighthouse on the outer shore, and on some of the inner shores of the bay, layers of consolidated material occur, capping the beaches and at times covering quite extended areas. They are often composed of very coarse materials and contain many shells, and illustrate beautifully, in many cases, the irregularities of beach bedding.

On the western side of the same bay, at Porto Santo, there is a curious example of consolidated beach structure, the only instance of the elevation of such material of which we are aware. At this place we find a cliff back of the beach, having a length of about 1,100 feet, and a greatest height of about thirteen feet, and composed almost entirely of sand and gravel, cemented by lime into a sandstone. The lower part of the cliff is very hard in texture, and contains numerous fragments of corals and shells, the latter being frequently found entire. Many of the species of both exist in abundance throughout the bay. The upper part of the cliff is of almost pure sand, and has been so incompletely hardened as to crumble readily between the fingers. The amount of calcareous material in the lower portion is very great, and it is said to yield a good quality of lime on burning.

Whether this cliff belongs to the same class of structures as the reefs or not, it is, at least, composed of the same materials, and must have been formed in about the same way. Its present elevated position—for high water reaches only slightly above its base—indicates that the shore has been raised at this point to a height nearly equaling that of the cliff. What gives an increased interest to this locality is the presence of a low kitchen-midden, only two or three feet thick, which overlies the entire cliff. It is composed of a dark-colored, sandy earth, packed full of the shells of the edible mollusks of the bay, with a few scattered bones, and occasionally a human skeleton.

The stone reefs of the southern part of the province of Bahia have been very fully described by Prof. Hartt in the "Geology and Physical Geography of Brazil." The principal ones are those of Porto Seguro and Santa Cruz, both being similarly situated and of about the same character. The former is the larger, and, beginning in front of a small bay formed at the mouth of a river, runs southward, skirting the shore for a long distance. In general structure it is like the Pernambuco reef; the outer edge has become very jagged from the undermining and falling down of blocks. But below the level of low water the reef rock extends seaward a hundred feet or more, forming a very shallow tract, over which one may wade when the tide is out. The inner edge is much thinner than the outer, being often overhanging, and it is flanked by a sloping bank of mud. The surface is of very uniform height, but quite rough, and interrupted by cracks and pools, which teem with marine life. From fractures at the end, it is apparent that the hardening has taken place to a depth of several feet below low tide.

At Gaurapary and Barra Secca, in Espirito Santo, and in their vicinity, are several imperfect reef formations, similar to many already described; and at the Abrolhos islands, as before stated, the sand and shingle beaches are often firmly consolidated by a lime cement.—*R. Rathbun, in American Naturalist.*

A RECENT VISIT TO POMPEII

By H. D. GARRISON.

EIGHTEEN hundred years ago Pompeii was a small Roman city of about 12,000 population, at the foot of Mount Vesuvius, on the shore of the Bay of Naples. Without other premonition than a series of earthquakes, the volcano, hitherto quiet and regarded as extinct, became wonderfully active, and in a few hours covered the village of Herculaneum with a sea of melted lava and buried Pompeii beneath a storm of hot ashes, stones, and mud. During the eruption, which began in the early part of the afternoon, absolute darkness prevailed, owing to the clouds of stones, ashes, mud, and steam. Nevertheless, nearly one-half of the population escaped with their lives, although all lost their property. A few of the fugitives returned and made some slight excavations for treasure or plunder soon after the catastrophe, and then the whole affair was forgotten so completely that even the sight of the city was unknown until accidentally discovered in 1750. The peasants who cultivated the fields and vineyards over the buried town, age after age, never even dreamed of its existence, and yet they were the lineal descendants of those who fled for their lives from the same spot seventeen centuries before. So much for the infallibility of Tradition. The eruption which destroyed these towns proceeded from an old crater, one-half of which still exists, about a mile east of the present crater, which is situated two thousand feet high, on a cone of modern construction. The old crater and its cone are called "Monte Somma." The distance from Pompeii to the old crater is at least seven miles. Herculaneum was a little nearer. Before the eruption the water of the bay bathed the walls of Pompeii. Now the shore is fully a mile distant, owing to the filling up of the bay by the ashes and stones which passed over Pompeii and Herculaneum. Pompeii is covered to the depth of forty or fifty feet, while Herculaneum lies beneath strata of ashes and hard lava, ranging in thickness from seventy-five to one hundred feet. Owing to the great thickness and hardness of the covering of Herculaneum, and to the fact that the modern villages Resina, Portici, and Torre del Greco are built over its site, but a very small part of this city has been disinterred. Circumstances being far more favorable at Pompeii, about one-third of that city has been uncovered, and still the work of excavation continues under charge of the Italian Government.

The resemblance of Pompeii to a modern Italian city is in many respects striking. The houses were principally of brick; but blocks and even pillars and walls of a porous kind of lava are very common. The bed chambers were remarkably small and without ventilation. The beds were generally very light, trifling affairs, mere cots, which could easily be carried about; but the bronze fittings of other beds, now restored in the Naples Museum, show them to have been full-sized double beds. The floors of the houses were generally composed of cement, often beautifully inlaid with small bits of marble. Some of the figures presented by this kind of mosaic work are exquisitely beautiful. In some of the houses most of the floors seem to have been of marble, and in others of large stones. The general absence of windows is a noticeable feature, but is accounted for by the fact that window glass, although known and in use in some of the houses, was not in general use. The stores or shops were usually small, and were only lighted from the front, which, as is the case to-day with many Italian shops, were entirely open during the day and closed up at night with strong boards. Water was conducted to many fountains, and to the bathing establishments, through lead pipes, which bear a large seam throughout their entire length, thus showing how they were made. Just as in all Italian cities to-day, the houses may be roughly divided into common and palaces. The latter were very numerous and were full of statuary and other ornamentations. Even in the common houses the walls were usually frescoed, often beautifully. These paintings are still almost perfect, and are hardly less artistic and beautiful than the works of the so-called "masters" of a much later period. The temples were numerous and remarkably elaborate, showing that the Pompeiians were as religious as are their descendants, although the idolatry then practiced comprised deities entirely different, in names at least, from those now worshipped. The hard lava steps leading to these temples, worn into deep paths by footsteps, show that church-going was at least as fashionable then as now. Although a small city, Pompeii had its coliseum, or grand theater, capable of holding about twenty thousand persons, in which were exhibited the fights of gladiators with criminals, wild beasts, and with each other. No Roman city was complete without an amphitheater. The streets are narrow and irregular in direction. They were all paved with large irregularly shaped blocks of hard lava, closely fitted together. In many places the ruts worn in these flinty rocks by wagons and chariots are fully six inches in depth. The sidewalks were from two to six feet in width, which is more than can be said of most of those in Rome or Naples, and were made of cement, brick, or stone, according to the fancy of the proprietor. The crossings of the streets were very peculiar. Two and often three enormous blocks of granite, three feet wide by four feet long and twelve to twenty inches high, were arranged as stepping stones. Wagons could straddle these blocks, but horses must have had much difficulty in getting between them, and certainly could not have passed over them.

The mills used in Pompeii were unlike any now in use, so far as I know, anywhere, and yet they must have been very effective. If you will conceive of a stone cut in the shape of two iron mortars, placed base to base and having a small opening through the bases, you will have a correct notion of the upper stone. Now imagine a large stone cone, set up vertically on a mass of brick work, and you will have before you the under stone. Of course, for use, the upper stone was placed like a cap upon the under stone, and the upper mortar then served as a hopper. When the lower part of this upper stone became badly worn or broken it was inverted, and the part which was the hopper now became the grinding part. The upper stone was turned by men by the aid of levers attached to ears or lugs.

The hammers, axes, hoes, picks, spades, hinges, locks, and burglar proof safes in use then were very similar to those in use to-day. They were nearly perfect in form, and hence improvement has been impossible. The surgical instruments were especially interesting, and embraced probes, silver catheters, metallic bougies, forceps, scalpels, many instruments apparently designed for dental operations, etc. An anal speculum observed is exactly like those now in current use. A three-bladed vaginal speculum, expanded by a beautifully cut screw, shows us that even in this line there is nothing new under the sun. Many specimens of either boluses or suppositories have been found. If these doubtful masses, of the size of musket balls, were intended as pills, it is evident that the Pompeiian physicians were not inclined toward the doctrines afterward put forth by Hahnemann.

It was our good fortune to be present during the excavation of the drug department or pharmacy of the house of a very rich Pompeiian. This rich spot had been reserved to be uncovered before some notable person, and it happened that a genuine princess was present on this occasion. Numerous glass bottles and earthen jugs were brought out as perfect as if buried but yesterday. A large elegant bronze lamp and a small glass lamp were found side by side. A pair of scales, with pans and beam resembling those of the ordinary analytical balance, next came. Numerous wine glasses, a glass plate, a large copper urn, and finally a beautifully polished bronze mirror, about eight inches in diameter, made their appearance. Except for two or three deeply rusted spots, the polish of the mirror was in a perfect state of preservation. I saw my face in it and could have shaved by it. If I had not seen this mirror taken out, I could hardly have been persuaded that it had lain in this moist rubbish eighteen centuries. Of the glass flasks, many were large and strong, but some were small and of exactly the shape we now call "Florence flasks." I noticed one of about two ounces capacity very particularly, and found it to be perfect in every respect. The glass was nearly white and was very thin, but yet evenly thick throughout the bulb part. The bottom was slightly indented, so as to enable it to stand upright. The neck was slightly funnel-shaped, so as to receive and retain a cork easily. In the museum at Naples, where many articles mentioned are exhibited, is shown a glass vase, taken from Pompeii, consisting of, so to speak, two strata, the interior of which is blue and the exterior white; but the exterior stratum only partially covers the interior one, in such manner as to present a multitude of figures, human and otherwise, just as seen in the cameo brooches, etc. I can understand how this effect might have been produced by cutting away the exterior stratum, as the cameo is produced, but the appearance of the figures did not justify this theory. Therefore I concluded that a blue vase was first produced, and, after being very skillfully painted with vitrifiable pigments, was again heated up to their melting point.

It is interesting to reflect that Pompeii presents us, as it were, a photograph of civilization nearly two thousand years ago. To see this picture, we are not obliged to employ the partial and biased descriptions of authors more enthusiastic than honest, but may use our own eyes. In this view, the Pompeiian catastrophe becomes a real blessing to history.—*Chicago Pharmacist.*

[Continued from SUPPLEMENT No. 175.]

ANOTHER WORLD INHABITED LIKE OUR OWN.

DESCRIPTION OF THE PLANET MARS—DISCOVERY OF ITS SATELLITES.

BUT to what cause are the clouds of Mars due? Evidently like ours, to the evaporation of water. And the ice? Evidently, also, to the congelation of water. But is it the *same kind* of *water* as we have here? Some years ago this problem remained unsolved. To-day it is possible to answer it.

The marvelous processes of spectroscopy have been applied to the study of the planets, principally by the learned English physicist, Huygens. Now the planets reflect the light that they receive from the sun; when we examine the spectrum of their light, then, we see the solar spectrum as if reflected from a mirror. By directing the spectroscope towards Mars, it was ascertained at first that, in the luminous rays given forth by this planet, there was a perfect identity with those which emanate from the central star of our system. But, by using more accurate methods, it has been found, during the later appositions of the planet, that the spectrum of Mars is crossed in the orange zone, by a group of black bands *coinciding with the lines* which appear in the solar spectrum *at sunset.* What atmospheric substance is it that produces these lines? By examining their position it is ascertained that they are due to the presence of neither oxygen, nitrogen, nor carbonic acid, but to watery vapor, which is distributed through the atmosphere of Mars in as large a quantity as it is in our own. The green spots of this globe are indeed seas—expanses of water analogous to those of the earth. The clouds are indeed vesicles of water solidified by cold. And further, this water being, as shown by the spectroscope, of the same chemical composition as ours, we know, moreover, that oxygen and hydrogen are there also.

These important proofs permit us to form an idea of the meteorology of Mars, and to see therein a very similar reproduction of that of the globe we inhabit. On Mars as on the earth, in fact, the sun is the supreme agent of movement and of life, and its action determines there results analogous to those that exist here. Heat vaporizes the water of the seas and carries it aloft into the atmosphere; this watery vapor assumes a visible form through the same process that gives rise to our clouds, that is, through differences of temperature and saturation. Winds arise through these same differences of temperature. We are able to follow the clouds as they are borne along by aerial currents over the seas and continents; and many an observation has, so to speak, photographed these meteoric variations. If we do not literally see the rain fall, we at least take it for granted, since the clouds dissolve, and are again renewed. If we do not see the snow fall, yet we assume that also, since, as with us, the winter solstice is accompanied by hoar frosts. Thus, there as here, there is an atmospheric circulation; and the drop of water of which the sun robs the sea, returns to it again by falling from the cloud which harbored it. And more, although we should firmly guard ourselves against creating imaginary worlds fashioned in the image of our own, yet the one under consideration presents us, as if in a mirror, with such an organic similitude, that it is difficult not to go a little further in our description.

In fact, the existence of continents and seas shows us that this planet has been, like ours, the seat of interior geologic movements which have given rise to upheavals and depressions of the land. There have also been earthquakes and eruptions that have modified the primary uniformity of the globe's crust. Consequently, there are mountains and valleys, plateaus and basins, steep ravines and cliffs. How do the rain-waters return to the sea? By springs, brooks, creeks, and rivers. So it is not difficult to see on Mars scenes analogous to those that form our terrestrial landscapes; purling brooks flowing over their bed of sun-gilded pebbles; rivers crossing plains, and falling in cataracts to the bottom of valleys, or slowly descending to the sea over their beds of fine sand.

The sea shores there, as here, receive the tribute of aquatic canals, and the sea is now calm and mirror-like, and now lashed by tempests; it is also agitated by a periodic movement of flux and reflux, since the planet has two moons to produce these tides.

By comparing more than a thousand drawings made by astronomers of all countries, and by making use of my own observations, I have been enabled to construct the world-map given on page 2787. An examination of this will show, better than any description, the geographical character of this planet. I have thought it legitimate to baptize the continents and seas of Mars with the names of the principal astronomers.

So, then, there is in space, at some millions of miles from here, an earth almost like our own, where all the elements of life are collected, as they are about us; water, air, heat, light, winds, clouds, rain, watercourses, and mountains. To complete the resemblance, we will also remark that the seasons there have almost the same intensity as ours, the axis of the planet being inclined 27 degrees (ours is inclined 23 degrees). The length of the day is 40 minutes greater than ours; it is exactly 24 hours 39 minutes and 35 seconds.

Before all this, is it possible to stop for a single instant at the statement of these elements and these movements without considering the effects that they have produced, and

that they are to produce? The physico-chemical conditions that have given birth to the first vegetation that appeared on the surface of our globe being realized up there as they are here, how could they have been in presence without acting in some way or another? Under what scientific pretext can we imagine an arbitrary prevention of the realization of these results? The fact is it would require an incomprehensible interdiction, a supreme veto, something like a permanent annihilation, to prevent the rays of the sun, the air, the water, and the earth (those four elements divined by the ancients) from entering at every moment into an organic evolution. While the least drop of water teems here with myriads of animalcules, while the ocean is the abode of thousands of animal and vegetable species, what effort would not our reason require to imagine that in the midst of like vital conditions, the world under consideration has been able to remain eternally in the state of a vast and useless desert?

Such is the chemical and physical knowledge that we have concerning this planet; we may complete it by an examination of its special mechanical conditions, such as its weight, its volume, its density, and the force of gravity at its surface.

The diameter of Mars is to that of the earth as 5 to 8; that is to say, it is almost half smaller. It is 4,400 miles in mean diameter, while the mean diameter of the earth is 7,912 miles. The surface of Mars is consequently two and a half times less in extent than that of our world. The total weight of the planet, or its mass, is only a tenth of the weight of our globe.

The mean density of the materials which compose this plant is less than that of the constituent matter of the earth, being 71 per cent. As a result of this density and of the dimensions of Mars, the weight of a body at its surface is extremely light. So the force of gravity at the surface of the earth being represented by 100, it would be only 38 at the surface of Mars, which, indeed, is less than it is on any other planet of our system. The consequence is that a terrestrial pound avoirdupois, transported thither, would weigh only about 6 ounces. A man weighing 150 pounds, transported to Mars, would not weigh 60 pounds. He would be no more fatigued from running 5 miles, than he would be from running 2 miles on the earth. The muscular effort brought into play by boys during the game of "leap frog," would, on the surface of Mars, not only permit them to jump over the backs of their companions, but even over the roofs of houses and the tops of trees. A study of modern statistics demonstrates scientifically that man is the product of the terrestrial planet, so far as organization is concerned (his soul being left out of consideration, a matter of which we will not speak of here). His weight, his stature, the density of his tissues, the weight and size of his skeleton, length of life, periods of work and sleep, the quantity of air he breathes, and the food he assimilates, all organic functions, even those that seem most arbitrary, and even to maximum periods of births, marriages, and deaths—in a word, the human machine all entire is organized by the planet. The capacity of our lungs and the forms of our chest, the nature of our food and the length of our digestive tube, the gait and the form of the legs, the sight and the construction of the eye, the thought and the development of the brain, etc., etc., all the details of our organism, all the functions of our being, are in intimate, absolute, permanent correlation with the world in the midst of which we live. The anatomical construction of our body is the same as that of the animals which precede us in the scale of creation. We are made as we are, because the mammiferous quadrupeds are made as they are; and so all species of animals follow one another like the rings of a same chain; and, in ascending from ring to ring, we find the first rudimentary organisms which are still more *visibly* yet none the less the product of the forces which have given them birth. This truth recalled, we see that the terrestrial human form has nothing of arbitrary, that it is the result of the state of the planet, and that, consequently, it differs on every planet according to the organic conditions of each one, which are so unlike those of another.

In tracing the formation of the zoological series, we may conjecture that the succession of species will have been strongly influenced, on Mars, by gravity. While that here the great majority of the animal races has been obliged to remain close to the surface of the soil through terrestrial attraction, and that a very small number have received the privilege of wing and flight, it is very probable that, owing to a very special disposition of things, the martial zoologic series has been developed by preference through a succession of winged species. In this case, the superior animal races are there furnished with wings. On our sublunary sphere, the vulture and the condor are the kings of the aerial world; up there the great vertebrate races and the human race itself (which is the result and last expression of it) have the very enviable privilege of enjoying aerial locomotion. The fact is so much the more probable, inasmuch as to the less gravity is added the existence of an atmosphere analogous to our own and perhaps more dense. So it is almost certain that the *inhabitants of Mars are of a different form from us, and fly in its atmosphere.*

Finally, let us add that this interesting planet proceeds in the heavens accompanied by two satellites. This recent discovery is one of the most curious in contemporaneous astronomy. It was made in 1877 by the aid of the great telescope of the Washington Observatory, and the best in the world. The American astronomer, Prof. Asaph Hall, undertook an attentive examination of the surroundings of Mars, from the beginning of the month of August, 1877, and a diligent observation of this neighboring planet during the whole of the favorable period of its greatest proximity to the earth. In masking the disk of his instrument to avoid the influence of light, he had the pleasure of discovering, on the 11th and 17th, two little luminous points which were accompanying the planet in its celestial march, and of observing them long enough to determine their orbits. This news was received like a thunder-clap by European astronomers, half of whom remained incredulous until they were fully informed. But the discovery was soon verified absolutely.

These two satellites are very minute worlds—the smallest that we know. The first appears to be about 7½ miles in diameter, and the second 6 only. They are, indeed, only the breadth of Paris! And yet they were perceived at a distance of 45,000,000 miles. In size they are not even terrestrial continents, nor even empires, nor even provinces, nor even departments. Alexander, Cæsar, and Charlemagne would have cared little to receive the scepter from them. Gulliver would have played with them, as a juggler with his balls; Micromegas would have forgotten them in his fob.

However, who knows? The vanity of men being generally in direct ratio to their mediocrity, it is very probable that the reasoning microscopic mites that swarm on their surface also take pride in possessing armies which tear each other in pieces for the possession of a grain of sand.

Such is the general physiology of this neighboring planet. The atmosphere which surrounds it, the waters which irrigate it, the sun rays which warm and light it, the winds which sweep across it from pole to pole, and the seasons which transform it, are so many elements for creating an order of life analogous to that with which our planet is provided. The low force of gravity at its surface must have particularly modified this order of life by adapting it to its special condition. So hereafter the globe of Mars ought no more to present itself to us as a block of stone turning in space in the sling of solar attraction, as a sterile, inert, and inanimate mass; but we ought to see in it a living world, ornamented with landscapes, where the noise of the wind is heard and the water reflects the light of heaven, a world peopled with numberless beings hovering about in its atmosphere—a new world that no Columbus will reach, but upon which, however, a human race now dwells, works, thinks, and, no doubt, meditates, as we do, on the grand and mysterious problems of nature.

CAMILLE FLAMMARION.

DETERMINATION OF THE DIAMETER AND VOLUME OF THE SUN.

THE Rio Janeiro *Jornal do Commercio* of April 1st has an interesting communication from the Imperial Observatory on the determination of the diameter and volume of the sun and of Mercury deduced from the observations on the transit of Mercury, May 6th, 1878.

The distance between the centers of the two bodies in the positions obtained by a method of observation devised by Mr. Liais, Director of the Observatory, was calculated by means of a formula in which the relative movement in right ascension of the centers of the two bodies, that is, the difference of their right ascensions near conjunction, was represented by means of the three first powers of the values of the time expressed in hours, either before or after conjunctions. An analogous formula gave the difference of the declensions of the centers of the two bodies.

The following values were obtained for the sun and difference of the half diameters of the bodies at the instances of 1st external and 1st internal contacts:

$$(R + r) = 15' \quad 56''374$$
$$(R + r) = 15' \quad 45''596$$

R and r being the half diameter of the sun and Mercury respectively.

From this are deduced the values:

$R = 950''985$ and $2r = 10''778$, which reduced to mean distance gives $R = 959''982 = 15'\ 59''982$ and $2r = 6''028$, which differs but slightly from the number $16'\ 0''0$ considered by Leverrier as the most probable, but is considerably different from that obtained by the micrometer by Todd, who gives $11''84$.

The diameter of the planets during the passage, obtained by observations of contact by the method of Mr. Liais, gave a mean value $2r = 10''74$, very nearly the same as that obtained from the contact of the limbs, thus confirming the accuracy of the result, which is considered to be as nearly exact as it is possible to expect.

From these data the diameter of the sun is calculated at one hundred and nine and a half times greater than that of the earth, and its volume at one million three hundred and sixteen thousand times greater.

The diameter of Mercury is thirty-four hundredths and its volume four hundredths that of the earth.—*Rio News.*

INVISIBLE SOLAR CLOUDS.

MR. R. A. PROCTOR mentions, in the Newcastle *Weekly Chronicle*, that Mr. Trouvelot, a skillful astronomical observer, whom he had the pleasure of meeting at the Harvard Observatory, announces a somewhat remarkable discovery in solar physics—or, perhaps, it should rather be said that the observation he has made, if confirmed by other astronomers, will involve a remarkable discovery. While he was observing the sun with the spectroscope of the Observatory just named, he noticed certain dark masses which cut out the light in the neighborhood of the C line, a well-known hydrogen line (near the red end of the spectrum). On looking at the same part of the sun with the telescope, he could see no such masses. The inference, therefore, is that there were clouds of matter floating above that particular part of the photosphere, which had the power of absorbing just that part of the sun's light, and that only; so that when the sun was examined by his red light only these parts appeared dark, whereas when he was examined by all his light they did not so appear. "I may mention here," writes Mr. Proctor, "an illustration of the effects of selective absorption, which seemed to me very effective when I noticed it a few days ago. Around a large window on my staircase there is a broad border of colored glass, dark blue at the top, bottom, and sides, and deep red at the corners; and to this window there is a blind of a deep yellow color. Now, when the blind is up, the red corners appear as dark, though not of the same color, as the blue sides; but when the blind is down the blue appears a great deal darker than the red. The effect is very striking and perplexing to those who see it for the first time, for the apparent effect when the blind is drawn down is not so much that the blue appears darker than before, while the red is scarcely darkened at all (though that is the real nature of the change), as that the red is suddenly made lighter. When the blind is drawn down the eye is, in fact, able to bear the light better; the blue, which is really made darker, because the blind cuts off those tints (blue, violet, etc.), which the glass alone allows to pass freely, seems to the eye, thus relieved, about as dark as before; while the red, which is little affected, because glass of that color absorbs very little of the orange and yellow light admitted through the blind, appears much less dark than before. Now this case well illustrates Trouvelot's observation. The blue glass corresponds to the clouds he saw when examining the sun by means of the red and orange rays. Just as the blue glass looks no darker than the red when the orange-yellow blind is raised, so Trouvelot could see no patches darker than the rest when he used a telescope admitting all the solar rays; and just as lowering the orange-yellow blind made the blue glass appear relatively dark, so when Trouvelot excluded all save the orange-red part of the sun's light, he saw the clouds which had before been invisible. In studying his observation and the illustration just described, it should be remembered that a substance which seen by transmitted light appears blue, indigo, or violet (as blue glass, for instance), is one which absorbs light belonging to the red, orange, and yellow part of the spectrum, and *vice versa.*"

THE TELEPHONE AND MICROPHONE CONTROVERSY.*

To the Editor of the Telegraphic Journal:

Permit me to criticise some of the statements and correct a few errors in your review of my recent work on the "Speaking Telephone, Electric Light, and other recent Electrical Inventions," published in your issue of the 15th ultimo.

1. In writing the above mentioned book, the object which I had in view was not "to advertise Mr. Gray's claim to be recognized as the first and true inventor of the speaking telephone, nor to support the claim of Mr. Edison to the discovery of the microphone;" but to present, without favor or prejudice, all attainable facts relating to the electrical transmission and reproduction of sounds, and let the reader judge for himself just what measure of credit is due to each of the different explorers in this wonderful field of discovery.

To this end I have published all attainable records bearing upon the subject, including those of the four principal inventors, Gray, Edison, Bell, and Dolbear, without alteration or omission.

2. You say "Mr. Gray was probably the first to conceive of a theoretically correct speaking telephone, but to Bell belongs the honor of achieving one. More than this, Bell did not simply succeed, where Gray failed, by adding some happy improvement to Gray's plan."

How could Mr. Gray's telephone fail if it was "theoretically correct?" If a theoretical device could not be made successful in practice, would it not necessarily indicate that the theory was incorrect? But Gray's telephone was not a failure, and instruments constructed in exact accordance with his original drawings and specifications are good articulating telephones. Moreover, Mr. Gray's method of producing articulate speech by varying the resistance of a battery current is much more effective than that of Professor Bell, subsequently invented, which depends upon magneto-induction currents generated by the action of the voice, as is fully proved by the great superiority of Edison's carbon telephone, which is based upon this principle.

3. Your statement that "Bell's telephone is entirely 'electro-magnetic' (magneto-electric ?), while Gray employs a battery," is misleading, as implying that Bell never used a battery with his method. Bell used a battery, as he says, until "it was proved that the only use of the battery was to magnetize the iron core of the magnet," for the effects were equally audible when the battery was omitted, and a rod of magnetized steel substituted for the iron core of the magnet.† Regarding the change from the electro-magnetic to the magneto-electric method, Professor Bell says that "Professor Dolbear, of Tufts College, not only claims to have discovered the magneto-electric telephone, but, I understand, charges me with having obtained the idea from him through the medium of a mutual friend."

4. How do you know that "it was an accident that Bell's transmitter happened to be like Gray's earlier receiver?" or that "had the latter never existed at all, Mr. Bell would still have arrived naturally at that form?" Supposing this to be true, however, could not the same observation be made with equal propriety in regard to any other invention or discovery?

For example, could you not say, "it was an accident that Vespucci's more successful discovery happened to be like Columbus' earlier one? Had the latter never existed at all, Vespucci would still have arrived naturally at the discovery of America!"

5. How can Bell's be "a totally different instrument from Gray's," when they both use the same receiver? I have nowhere asserted that Professor Bell's telephone was identical with Mr. Gray's. On the contrary, I have stated distinctly that "in 1876, Bell invented an improvement in the apparatus for the transmission and reproduction of articulate speech, in which magneto-electric currents were superposed upon a voltaic circuit."

It no more detracts from Professor Bell's achievement that he employs a portion of Mr. Gray's invention to produce the magneto telephone, than it does from Mr. Edison that he employs a portion of Mr. Gray's invention to produce his improved carbon telephone—the same receiver being employed in all.

6. In the accounts which have been published of experiments with the microphone, the statement has frequently been made that minute sounds are actually magnified by it, in the same sense that minute objects are magnified by the microscope. A little reflection will show, however, that there is no real analogy in the action of the two instruments. The sound that is heard in the receiving instrument of the microphone, when a fly is walking across the board on which the transmitter is placed, is not the sound of the fly's footsteps, any more than the stroke of a powerful electric bell or sounder is the magnified sound of the operator's fingers tapping lightly, and, it may be, inaudibly, upon the key. This view of the subject readily explains why the microphone has failed to realize the expectations of many persons, who, upon its first exhibition, enthusiastically announced that by its aid we should be able to hear many sounds in nature which had hitherto remained wholly inaudible.

Referring to this idea, that faint sounds are not augmented by the microphone, you say that "this shows too well that Mr. Prescott does not know what a microphone is, and has never heard one. If Mr. Prescott has not himself heard minute sounds transmitted to a distance by a real microphone, why does he also disbelieve all the high authorities in this country who have?"

Is it possible that a reviewer who sets himself up to criticise the style and grammar of a book, as well as the accuracy of its statements, is unable to recognize the difference between augmented and transmitted?

Suppose that an apparatus could be so delicately arranged that the tread of a fly could be made to close an electric circuit and explode a powder magazine, would you contend that the force of the explosion was due to the augmentation of the power of the fly?

Permit me to close this brief notice of your review by quoting from its concluding paragraph. "It is a strange method this of writing a scientific review. Let us hope it is not common in England."

GEORGE B. PRESCOTT.

New York.

* From the *London Telegraphic Journal.*

† See "Researches in Electric Telephony," by Professor Alexander Graham Bell, "Journal of the Society of Telegraph Engineers," Vol. VI., No. 20, pp. 406-410.

AMERICAN DISTRICT TELEGRAPH BOYS.

THE varied and peculiar services rendered by the American District Telegraph Company have made it indispensable to the public. The messenger service reaches all classes of the community, and the neatly uniformed messenger boys employed by the company are ubiquitous, and ready at any time, day or night, to respond promptly to the multifarious demands which are constantly being made upon them. The following article, recently published in the New York *Tribune*, shows the variety and character of the services they are called upon to perform, and will no doubt surprise those who have regarded the company as organized merely to supply messengers to run errands, deliver notes, and transact business of a similar character.

The managers of the company are constantly seeking to extend the usefulness of the system, and to adapt it more thoroughly to the convenience and requirements of the public. Their efforts have been very successful, and from a comparatively small enterprise of limited scope and facilities it has rapidly progressed to its present position an an important and indispensable department of the telegraphic service.

The great majority of persons are probably not aware of the many and varied uses to which the District Telegraph system is put by all classes. The company employs at present about 600 boys, who are paid on an average of $3 a week. The amount of work done by these 600 boys may be inferred from the fact that the messenger receipts average about $800 a day. The greatest demand for the boys is during the holidays, and the dullest period is during a portion of the summer. The boys answer summonses at all hours from 4,682 boxes, which are in dwelling-houses, and on the corners of blocks, in all parts of the city. In some blocks in the upper part of the city nearly every house has an alarm box by which a messenger may be summoned for any purpose in less than five minutes.

The uses to which these hundreds of boys are put appear to reveal many curious phases of character. There are many young men, too, who are employed by the company for various purposes. Of late there has arisen a demand for escorts to places of amusement, and from one house to another. In the former case the address of the person applying for the attendant is taken, and word is telegraphed to the central office for an escort. The one who answers the summons is given the address and a letter of introduction, and accompanies the applicant to whatever theater she desires. The escort pays for the car fares and tickets from money that his newly made friend has given him. He attends her back to the hotel and receives $2 for his services.

This custom of employing escorts has become a regular practice, and appears to be growing in favor. One evening recently, there were eight ladies at six different theaters, including Booth's during the Kellogg opera season, whose escorts were furnished "to order." The men employed for escort duty are carefully selected, and in the majority of cases they are in the service of the telegraph company during the day. As a rule the demand for these disguised messengers comes from married women, widows, and maiden ladies of mature years. Not infrequently two women apply for one escort. It is said that the daughters of a prominent professional man and of a well-known clergyman are among those who take advantage of this curious custom. Many of the women who apply for these attendants are strangers to the city, ignorant of the situation of the theaters.

Men, however, as well as women, employ escorts for various purposes. Many, in fact most of the men too, who require the services of the messengers are strangers, who wish for guides to show them the "sights." The new Post Office and other public buildings are the places which the majority of the country visitors desire to visit. It is said that one old gentleman from the country who has been repeatedly "fleeced" by gamblers, keeps a good guide by his side every hour while he is in the city. These guides appear with or without uniforms according to the fancy of the applicant. Most of them are experienced men who understand human nature, and who are thoroughly acquainted with the city. The charges for guides vary from 35 to 75 cents an hour.

Another use that is made of the District Telegraph messengers is to attend children, particularly girls, to and from school. About 75 children are at present called for in the morning at their homes and in the afternoon at their schools by messenger boys. It is said that there is one mother who will not allow any of her children to leave the vicinity of the house unless accompanied by a messenger-boy in uniform. Recently she had taken a particular liking to one messenger, and employs him altogether on this special "nurse detail," as it is called. The boys are also required as "night nurses" and "night watchers." The practice, however, of hiring the messengers to watch patients afflicted with contagious diseases has been forbidden by the company.

Cases are not unknown where a messenger has been summoned and sent in search of a missing husband, who was supposed to be at one of his favorite haunts. It is related that in one instance a messenger started out with a complete list of the places in which the truant was likely to be found, and at last discovered him. But he was unable to persuade him to come home, and so reported. It is not an uncommon thing for a messenger to be sent home with an intoxicated person. In one instance of this kind recently, a man was labelled and sent home, and when the messenger gave him up he obtained a receipt for "one drunken man." Messenger boys and men are also extensively employed as detectives for various purposes. Some of the small boys are said to be very clever at this work, and on account of their comparatively small size they are able to mingle with men and to observe much without attracting notice. It is said that a lady engaged two of the shrewdest of the young men in the employ of the company for this purpose, paying them double rates and receiving their reports daily. It is also stated that in a recent divorce case, a messenger boy was detailed to watch the child for whom the parents were contending. The nurse, however, observing that she was watched, resigned her position because she could not meet a certain male friend without having the fact reported. On the other hand, instances have been known where nurses hired messenger boys to take care of the children in their charge while they enjoyed a flirtation around the square or park.

Special messengers, or men or boys in plain clothes, are assigned to special duty as "spotters" of suspected clerks in stores, and they are said to have done excellent work. In fact, detective duty appears to be peculiarly adapted to those in the messenger service.

Another use which has been found for messenger boys is the paying by proxy of New Years' calls. In one sense, too, they may be said to receive calls oftentimes. Many gentlemen have lately adopted the custom of sending their cards to their friends on the first day of the new year instead of calling in person. With many ladies, also, the practice has grown up of receiving cards by a messenger boy hired for the purpose, or of securing a boy for New Year's day to attend the door and announce the visitors. Messengers delivered 5,960 cards from gentlemen, and a great many houses were supplied with boys as doorkeepers, on last New Year's day. On Christmas eve, over 600 boys were carrying Christmas gifts from one point to another, and on Thanksgiving day almost one-half of the entire force resolved itself into a committee of turkey carriers. Messengers are also employed as ushers at fashionable weddings, and as "managers" of the arrangements for carriages on such occasions.

The books of the company show the services for which the boys have been required, and many laughable records are to be seen. One boy was detailed to take care of a lady's poodle, for which he was paid 30 cents an hour. An escort was required to attend to the theater a lady whose husband was to "come later." A young man was once telegraphed for in order to bring a bumptious servant to terms. During political campaigns the boys are employed extensively to distribute documents. Car drivers, and indeed all classes of people who have to get up very early in the morning, are peculiarly dependent upon the messenger boy system. The books also show that the messenger boys have been used to order dinners, to buy all kinds of liquors, to do shopping for women, to pay bills of all amounts, and even to borrow umbrellas. Not unfrequently boys are sent to pawnbrokers' shops with articles.—*Journal of the Telegraph.*

HEINRICH WILHELM DOVE.

PROF. HEINRICH WILHELM DOVE was born at Liegnitz, Silesia, on October 6, 1803, and at the age of eighteen passed from the schools of that town to the Universities of Breslau and Berlin, where for the next three years he devoted himself assiduously to the study of mathematics and physics. In 1826 he took his degree of Doctor of Philosophy, his thesis on the occasion being an inquiry regarding barometric changes; and it is further significant of his future lifework that his first published memoir was a paper on certain meteorological inquiries relative to winds, these two subjects holding a first place in the great problem of weather changes.

Dove began his public life as tutor and professor at Königsberg, where he remained till 1829, being then invited to Berlin as supplementary Professor of Physics. His strikingly clear sighted, bold, and original intellect turned instinctively to that intricate group of questions in the domain of physics which comprise the science of meteorology, and his success in these fields as an original explorer was so marked and rapid that he soon achieved for himself a seat in the Royal Academy of Sciences, and some time thereafter was raised to the distinguished position of the Chair of Physics in the University of Berlin.

Among the scientific and fashionable circles of Berlin he took first rank as a lecturer, the combined qualities of accurate science, fine imagination, lucidity of style, commanding presence, and the extent over which his utterances were heard, making him out as the Arago and Brewster of Germany. Germany showered on him in profusion those honors and offices which it gratefully bestows on learning and science; and perhaps there is no learned or scientific society of any note that has not the name of Dove enrolled among its honorary members. After a protracted and hopeless illness, he died on Sunday, April 6, in the seventy-sixth year of his age.

In the Royal Society's Catalogue of scientific papers, the lists under Dove specify 224 memoirs written between the years 1827-73. These show him to have been a successful worker and investigator in electricity, optics, crystallography, and in such practical matters as measures and the art of measuring, or the metric system of civilized nations. But it was to meteorological inquiries he devoted his full strength and all the powers of his mind, and, by his herculean but well directed labors he has written his name in large imperishable characters on the records of science.

His fame rests on the successful inquiries he carried out with a view to the discovery of the laws regulating atmospheric phenomena which apparently are under no law whatever. The work he will be long best known by is his isothermals and isabnormals of temperature for the globe, in which work one cannot sufficiently admire the breadth of view which sustained and animated him as an explorer during the long toilsome years spent in its preparation. Equally characterized by breadth of view, and what really seemed a love for the drudgery of detail even to profuseness when such drudgery appeared necessary or desirable in attaining his object, are his various works on winds, the manner of their veering and their relations to atmospheric pressure, temperature, humidity, and rainfall, and the important bearings of the results on the climatologies of the globe; on storms and their connections with the general circulation of the atmosphere; the influence of the variations of temperature on the development of plants; and the cold weather of May—to which may be added the valuable system of meteorological observations he gradually organized for Germany, and the many full discussions of these which he published from year to year.

It is no small praise to pass on his work to say that those views he propounded, which subsequent researches are likely to modify materially, are those he arrived at by methods of investigation necessarily defective at the time. Thus, for instance, in inquiring into the law of storms, it was not in his power to work from isobaric charts, seeing that the errors of the barometer and their heights above the sea were known in but few cases. When we consider the condition in which he found man's knowledge of weather, and the large accessions and developments it received from his hand, the breadth of his views on all matters connected with the science and the well directed patience, rising into high genius, with which his meteorological researches were pursued, there can be only one opinion, that these give Dove claims, which no other meteorologist can compete with, to be styled "the Father of Meteorology."—*Nature.*

PHOSPHORESCENCE.—M. Nueesh.—In a certain butcher's shop all the meat became strongly phosphorescent and remained so as long as sound. If putrefaction set in and *Bacterium termo* made its appearance the luminous appearance ceased. None of the customers of the meat experienced any inconvenience from its use, and no similar phenomenon was traced in other butcher's shops in the neighborhood.

TOLLES' ONE-SEVENTY-FIFTH INCH OBJECTIVE. ITS HISTORY, CONSTRUCTION, AND USES.

A Lecture delivered before the New York Academy of Sciences, Jan. 6, 1879, by Dr. EPHRAIM CUTTER, of Boston, Mass.

THE design of this lecture is not to claim that the 1-75th inch objective of Tolles is better than anything ever produced, but simply to put on record the main facts in relation to it as matters of history. Whatever is said must be taken in this light. I desire to put in your possession all the principal facts of a not too technical kind in relation to this celebrated instrument of precision, leaving the question of its comparative value to be settled by the lapse of time.

In my history I am obliged to bring in certain characters and go into some personal relations which, if left out, would impair the perfection of the narrative and render the story incomplete.

Who is Robert B. Tolles?

He was born in West Winstead, Conn., in September, 1827. Very early in life his mind was interested in fine instruments. On a visit to central New York in 1850 he happened into the workshop of the celebrated Mr. C. A. Spencer, and there he found the place where the pursuits were congenial to his tastes, and he decided to become a pupil of one whose name is honorably associated with the early history of the making of microscopes in America. He remained with Mr. Spencer for many years. While there he lost the dearly beloved companion of his life under very trying circumstances. This loss of his wife seemed to have changed the course of his life. For to drown the bitterness of his grief he threw the whole energies of his inventive mind into the difficult work of improving the various parts of a microscope. How industrious he has been may be seen by a partial list of his productions:

1. In 1856 he invented his achromatic amplifier.
2. 1866, prism in the side of the objective for illuminating opaque objects.
3. He was the first to claim 180 degrees of angular aperture for his objectives and prove it.
4. 1855, invented and patented his solid eyepieces.
5. 1864, invented the binocular eyepiece. Both were copied by Hartnack, and sold as his own invention.
6. About 1862, cover adjustment by moving the back and middle combinations, the front remaining stationary.
7. Wet and dry fronts to objectives, 1867, '68, '69.
8. Trunnion joint to compensate for wear in the stands.
8 *a*. 1858, Pocket magnifier, achromatic—flat field—triple lenses.
9. 1875, illuminating apparatus for microscope, swinging concentrically around the object or focal point. 1871-2.
10. Very thin stage with rectangular motions by friction rollers, with complete rotation on the optical axes—one thing that has never been copied or imitated.
11. Simplified camera lucida.
12. Oblique illuminator for thick stage.
13. Solid catoptric erecting eyepiece.
14. Erecting apalanatic 3 system eyepiece for telescope.
15. Before 1865, telescopic magnifier, the principle rediscovered in Europe.
16. Short focus, quadruple, cemented object glass for telescope.
17. 1867, made his first immersion objective, a 1-6th, that resolved Nobert's 19th band—probably the first time that it was seen. Witnesses: Mr. R. C. Greenleaf and C. Stodder, both of Boston.
18. 1872, semicylinder for proving that the angle of objectives may exceed 82 degrees with objects mounted in balsam, by excluding all light of less incidence than the half of the maximum angle—now made as the "transverse angle."

In 1867 Mr. Tolles removed to Boston and there founded the Boston Optical Works. Here he now resides, devoting himself wholly to his department and developing many new ideas.

After the new works were established, G. B. Harriman, D.D.S., of Tremont Temple, Boston, applied to Mr. Tolles for improved microscopic tools. Who Dr. H. is may be seen from the list of his works appended here:

1. Free Mercury in Vulcanite. *Dental Cosmos.* March, 1870.
2. The Discovery of Cells with Fibers in the Dentine at the Junction of the Enamel and Cementum. *American Journal of Dental Science.* May, 1870. Illustrated.
3. The Effects of Animalcules on the Teeth. *American Journal of Dental Science.* Nov., 1870. Illustrated.
4. The Discovery of Nerve Fibers in the Soft Solids of the Dentine. *Dental Cosmos.* Jan., 1870.
5. Bone Fibrous. *American Journal of Dental Science.* Illustrated. June, 1871.
6. The Structure and Development of the Teeth. *Dental Register.* July, 1872. Illustrated.
7. The Period when the Teeth Begin to Form. *Dental Register.* August, 1872.
8. Is the Dentine Tubular? *Dental Register.* September, 1872. Illustrated.
9. The Dentine Cellular and Fibrous. *Dental Register.* 1872. Illustrated.
10. What Will Make Good Teeth? *Dental Register.* November, 1872.
11. What Makes Teeth Decay? *Dental Register.* 1874.
12. Anæsthetics—Three Deaths from Chloroform and Ether. *Dental Register.* Dec., 1874.
13. The Microscope in Analysis. New Bedford *Mercury.* January, 1872.
14. The Microscope. *Dental Register.* March, 1874.
15. Anæsthetics. *Dental Register.* January, 1875.

UNPUBLISHED.

16. The Use of 1-75 Objective in Micro-Chemical Examinations of Blood Stains.
17. Professional Success.
18. The Fifth Pair of Nerves.

In working up the materials of the above papers he required and sought to have the best objectives. It was for him that Mr. Tolles made his first 1-16th inch objective (first class immersion). In 1870 Mr. Tolles made his first 1-50th inch objective, also for Dr. Harriman. This is a truly first-class instrument. With it has probably been taken the most successful microphotographs of the morphology of diseased blood. They were pronounced in Paris (see *Journal de Micrographie*, Oct., 1877) to be not inferior to any ever taken. Being so well satisfied with this objective, Dr. Harriman, desiring to go to the utmost stretch of human abilities in the prosecution of his demonstrations and verifying his researches—that is, the demonstration of the fibers in dentine and of the nerve fibers in the soft solids of the den-

tine and the enamel (a fact that those who have been under dentists' hands would not care to dispute)—then approached Mr. Tolles with a proposition to make a 1-75th inch objective. He gave him a *carte blanche* as to price and time. At that time the idea was unheard of. Since then it has been said that a 1-80th had been made by Powell & Lealand, but it has not been heard from.

At first Tolles would not entertain the idea at all, but finally by persistence Dr. H. induced him to undertake it without giving any positive assurances as to its accomplishment. However the 1-75th inch objective was delivered on July 1st, 1878. Price paid $400. This is the only one Tolles has made.

It is classed as wet or dry—three systems—170 degrees of angular aperture. Working distance 1-250th of an inch.

It can be used only on a first-class stand. The stage must be absolutely at a right angle to its axis. This the writer has found by practical tests. The screw collar moves only about 1-8th of the circle.

The aperture of the lens on its face is 1-64th of an inch; the opening on the opposite end of the objective is ¼ inch. It is about 2¼ inches in length. It has the society screw. I have not been able to obtain the mathematical formulæ of its construction,

For use, a first class stand is required. The object must be a suitable one. It must be found with a low power objective, generally a 1-5th. The object is brought to the center of the field; then a 1-16th inch objective is tried on it; the object is centered again. Next a 1-50th inch is tried on it. The object is centered. Finally the 1-75th is tried on it. By using the powers of an increasing magnitude successively, the best insight is gained into the subject and its features are best understood.

The Illumination.—This has been a subject of study, and improvements have been made. But the direction has been in the direction of simplicity. It has been found, for example, that the direct light of a common kerosene flame, taken sideways on its thin edge, furnishes the best illumination with which to use this objective. Also, it is necessary to employ a condenser. We have found the eyepiece that goes with the Tolles B stand placed under the stage answers the best in all respects. The field is of a remarkable clearness and flatness. The resolution is good. The definition, when the enormous amplification is considered, is remarkable. It is satisfactory; the photographs prove this.

It has been our practice to use a low light stand, and bring the axis of the microscope to an angle of 90 degrees to the flame. The manipulation is very delicate. The instrument is sensitive to surrounding impressions. It is difficult to find a place where to use it where the shocks of moving bodies do not disturb the observations. Even a slight grasp of the hand on the arm of the microscope that connects the tube with the trunnion joint is sufficient to displace the focus. We have found that down cellar is the best place to work with this objective.

The magnifying power of the 1-75th is 750 diameters at the standard distance from its face, to wit, ten inches. If taken in connection with a two-inch eyepiece which magnifies 5 diameters, its power will be 3,750 diameters. With an inch eyepiece its power would be 7,500; with a half-inch eyepiece its power would be 15,000 diameters.

Now what has this objective done? Of course, the class of objects that can be studied with it is limited. Its principal use has been, first, in ordinary microscopy; second, in heliomicroscopy or projections with the sunlight; third, in microphotography. In these three departments it has filled a place positively and satisfactorily

The objects have been the red and white blood corpuscles—the forms found in diseased blood—the spores, sporangia, and filaments of yeast (we believe that yeast has filaments, though it is denied by some); the *Asthmatos ciliaris*—a parasite found by Dr. J. H. Salisbury in the nasal excretions of persons suffering under contagious colds, and which we have verified in many instances; amœbæ; vibriones, and bacteria; most especially, the histology of bone and teeth.

The sunlight projections were fine; the yeast sporangia showed the protoplasmic movements of the contained spores moving to and fro for the distance of ¼ inch.

Just here we would remark that heliomicroscopy, or more commonly called solar microscopy, should be more employed by micrologists. Beside the modern first-class objectives the older solar projections appear like the work of toys. The contrivances for this purpose are simple and easily managed. For a full description of the apparatus used in microphotography with the 1-75th, see article to appear in the *American Journal of Sciences* for July, 1879.

At this point the remarks were concluded; the room was darkened, and with Marcy's sciopticon successful projections were made upon the screen of the first microphotograph taken with this objective, to wit, the appearances of the white blood corpuscles in consumption, as pointed out by Salisbury.

Note: the photograph was shown simply as a specimen of work of the objective, not in demonstration of the intimate nature of consumption, which however interesting, was not the subject of discussion.

Also microphotographs of yeast (wet); in order to compare the work, microphotos of like objects taken with the 1-50th inch objective were projected.

Some of the microphotographs of the enlarged colorless corpuscles found in the blood of syphilitics (Salisbury). See *American Journal of Medical Sciences*, 1867.

Finally, the lecturer arranged some of his own blood dry on a slide, and the members had an opportunity of seeing for themselves the appearances of the red blood corpuscles under the 1-75th and also the 1-50th inch objective.

Tremont Temple, May, 1879.

THE FLESH OF DISEASED CATTLE AS FOOD.

DR. E. DECROIX, ex-Veterinary Surgeon-in-Chief of the French Army, writes to the editor of the *Lancet*, *apropos* of the plague which is affecting the cattle of the English army in Afghanistan, as follows:

"Allow me to assert," he says, "that the flesh of animals affected with the 'cattle plague' may be eaten without fear and without endangering the health. In support of this assertion, I rely on a large number of observations that I have been collecting together for a long time, and especially on experiments that I have made myself. At Paris, from the 23d of February to the 8th of March, 1871, after the siege, the cattle plague existed among the oxen and cows collected at the abattoir of Villete as food for the public. Many of these animals, affected with the disease, were slaughtered for the meat market, yet no accident happened to the consumers. For my own part, I went to the slaughter-house during fifteen to twenty days for the flesh of the animals that had died of the plague. I ate this boiled, stewed, roasted, and in the form of soup, etc., during all that time without feeling the least illness from it. Moreover, I several times invited friends, especially veterinarians, who also ate this meat with impunity. Desiring to carry my experiments still further, I ate the flesh raw, in order to remove the fears of those persons who might have been alarmed in learning that certain butchered animals had been afflicted with the plague. The soldiers of the army in Afghanistan may eat, then, the flesh of animals affected with this disease. There is no danger even in eating meat of animals that have died; but, for certain reasons, it is preferable to order the cattle slaughtered at the first symptoms of the disease. In the Crimea we allowed ourselves to go hungry, while many horses and sick beeves were lost. With more experience at the present time, I urge our brothers in arms of England to make use of the cattle affected with the disease under consideration; they will suffer no ill effects from it."

SUN AND AIR BATHS.

By C. H. MERRICK, M.D., of Canyonville, Oregon.

I REMEMBER reading an editorial in the *Medical and Surgical Reporter*, in which the idea was advanced that the prominent feature of medical knowledge and practice, in the near future, would be directed to the prevention rather than the cure of disease. The thought is a good one, and truthfully reflects the sentiment which actuates every genuine member of our noble profession. We have been told a thousand times by the great lights in the profession, and the sentiment finds a welcome in the heart of every honest physician, that it as much our mission to prevent disease as it is our duty to cure its unfortunate victims.

Many years ago my attention was drawn to the wonderful capabilities and functions of the human skin; its power of enduring heat and cold; its condition and office as regards the cause and cure of many of our common diseases. Sea captains have related how the natives of the tropical islands would lie around in almost a nude condition, on the decks of vessels, with the sun's rays pouring down so hot as to melt the tar from the planks, yet appear not the least oppressed by the heat. Dana, in his "Three Years' Before the Mast," speaks of sailors dashing cold water over their naked bodies in air below the freezing point, while doubling Cape Horn. Thousands of similar facts might be mentioned. Medical literature abounds with references to the skin, and the effect which light, air, and temperature, applied directly to the surface of the body, have upon health and disease. Sun baths are not a feature of recent medicine. Dr. Coventry says: "The sun's rays are indispensable to prevent the inception and progress of tuberculosis." (*Trans. N. Y. Med. Society*, 1855.)

I might fill many pages of your journal with quotations of a similar character, but my object is not to argue a point about which there is but little difference of opinion. Facts are of more importance, and in hopes of leading medical men to use, oftener than they do, the power of light and air in the treatment of various diseases, I shall give my limited experience with this branch of therapeutics.

CASE 1.—Telegraph operator; aged twenty-five; thin in person; suffers with cold hands and feet, especially after going to bed. Cough frequent but not distressing. Constantly "taking cold;" otherwise general health good. Read to him portions of Dr. C. R. Agnew's lecture on otitis. "How may you and I learn to endure draughts and lessen our tendency to catch cold? By diminishing the morbid sensibility of the surface of the body. This can be brought about by graduated exposure and friction of the skin in a daily air or sun bath, followed by such local sponge baths as you may be able to speedily react from. It is well, at first, in the air bath, to expose the body for a very short time only, such as would be spent in walking briskly across an ordinary bed chamber. After a little practice the length of the exposure may be increased. The salutary effect of this exposure may be still further increased by two or three deep, chest-filling inspirations, with closed mouth, and by a few such movements of the arms as would tend to invigorate the chest muscles and quicken the action of the heart. The entire surface of the body should be rubbed briskly with hair mittens, until there shall have been produced a sense of glow and warmth of the skin. Under all circumstances, it would be better to use a sunny room. Of course, imprudence in exposing the untempered nervous system of the skin for too long a time to a low temperature, would defeat the grand purpose of the training, and bring the method into contempt. Invalids should enter upon it deliberately and continuously." (*Clinical Lectures*, Seguin, page 138.)

The patient was pleased with my prescription, and although in mid-winter, commenced "taking it." After a lapse of four months he wrote to me: "Cough all gone; hands and feet warm; gained six pounds in flesh; and as telegraph operators say, everything is O. K. When I hear persons say they have a cold I laugh at them, and tell them they ought to be ashamed of themselves for having a cold when they can prevent it."

I should have mentioned that the first ingredient in my prescriptions of air and sun baths is the requirement that patients shall not sleep in the clothes worn during the day, and in no case must the exposure of the body to air or water be continued so as to produce chilliness and discomfort. I omit here all details as to good ventilation in sleeping rooms, diet, regularity of the bowels, etc.

CASE 2.—Merchant; aged thirty-five; annoyed with rheumatism, constipation, and sleeplessness. No cough except when having "a cold," which is pretty often. Sometimes for a whole week will not sleep more than one or two hours out of every twenty-four. Prescribed drugs and change of diet for constipation; air baths and frictions to the whole surface of the body; hot water baths once or twice a week. Three months after commencing treatment patient reported every symptom much better; can sleep six to eight hours every night; rheumatic pain in the back all gone; coughs some occasionally, but not worth noticing.

CASE 3.—Unmarried lady; nineteen years old; tall, but in fair condition as to flesh: has coughed at night for two years; troubled with nasal catarrh, sore throat, and a constant tendency to "take cold." Has taken gallons of patent medicines to ward off consumption, of which disease she has a horror. Some soreness under the clavicles, as she complains of being hurt when I use moderate percussion. Bowels and uterine functions regular and natural.

I gave her a lecture upon the skin and how it should be treated. She thought it was not possible for her to wear flannel underclothing, as it "irritated the flesh so;" but after a few weeks of trial she subdued that sensitiveness of the skin. She writes: "Father had a bay window built to my bedroom, facing to the east, and now, every morning, when the sun's warm rays come over the eastern hills, they find me ready to receive their health-giving influence. I am surprised at the pleasure and benefit I receive from daily sun and air baths; sun and air in the morning, air at night; for I must tell you that I sometimes sit and write or read two or three hours before going to bed, clothed only with a loose robe, made of common mosquito bar netting, to keep the flies from annoying me. My friends, as well as I, are delighted with the improvement in my general health. The frictions to my chest, with gentle filliping over and under the collar bones, and especially the trapezium exercise, has removed all soreness from my lungs and developed the muscles of my arms and shoulders very much."

I should have mentioned that I directed this patient, as well as some of my male patients, to fix a swinging bar in her bedroom, and when she wished to stretch or yawn, to catch the bar with her hands and support her body for a few seconds, free from the floor.

I have a number of other cases I might report, but to save space I will condense them into a few general statements. Another young lady, annoyed with obesity, declares that she has reduced her weight fifteen pounds in six months, by daily frictions to the whole surface, in the cool air of her room. She uses dry towels and her bare hands in preference to woolen mittens or hair brushes. She remarks that my prescription is far better than the "anti-fat" humbug. Physicians will see nothing unreasonable in the statement that air baths in one case increase the quantity of flesh, and reduce it in another, as paucity of flesh and obesity are both departures from a normal, healthy condition.

A gentleman, forty years of age, writes that he is surprised to think that he has lived to be of that age without experiencing the luxury of air baths. His neuralgia has left him entirely, and what seems to please him as much as any feature of the "cure," is the restoration of virility, a partial loss of which seemed to affect his mind unfavorably. To the profession I here remark, that in addition to the reading of Agnew's lecture to him, I gave him a good dose from Acton on the "Reproductive Organs."

I am watching a case of asthma of ten years' duration; the patient a clerk in a county office. Latest report indicates a decided improvement in all the symptoms. The patient is enthusiastic in his praise of air baths. "Every day I long for the evening to come, when I can bolt myself in my room and read and write for hours, with not even a fig leaf to prevent free contact of air with my skin." I have heard that John Quincy Adams attributed his vigorous health to his daily practice of passing an hour or more in his room divested of all clothing. I believe it.

In conclusion, I notice an idea which, no doubt, has already arisen in the minds of my readers, namely, the difficulty of putting the air and sun bath cure into practice. Laboring men and women cannot give the time often necessary to harden the skin against the tendency to take cold. Our houses are not well arranged for such daily exposure of the body as is necessary. To such objections I reply that if life and health are worth preserving, and if this system of baths adds materially to the restoration and preservation, then, "where there is a will there is a way," and some expedient will be resorted to in order to reap its benefit.—*Med. and Surg. Reporter.*

CLERAC'S TUBE.

PROFESSOR BARRETT, says the *Telegraphic Journal*, has kindly sent us a copy of his lecture on Mr. Edison and his work, which is now published as one of the science lectures for the people, and a very interesting one it will form. It is right that one who addresses the people on matters of science should render scrupulous justice to the merits of discoverers and inventors, for the subject is one on which the people cannot judge for themselves, and must implicitly trust their teachers. We are, therefore, gratified to find that Clerac's tube is referred to by Prof. Barrett in the printed pamphlet as follows: "It has been said that a French electrician, M. Clerac, discovered this property, and made an instrument such as I have described, some twelve years ago. In fact Prof. Hughes, whose name is well known in connection with his invention of the printing telegraph and the discovery of the microphone, writes to me that since 1866 he has had in his posession a resistance tube made by Clerac, in which plumbago, more or less compressed by a screw, was employed and the resistance made to vary by pressure. This tube has been seen by many. It is known that Clerac used squeezed plumbago as a stated resistance, but I can find no record of its being used as a variable resistance. Nevertheless, eminent eyewitnesses declare such was the case, and I do not doubt their statement, though this does not amount to publication in the scientific sense. Edison certainly independently re-discovered and greatly increased the importance of the effect of pressure on carbon dust. The only person who, previously to Edison, seems to have noticed that pressure made any difference in conductivity, was a well known electrician, the Count du Moncel, who, twenty years ago, pointed out this fact as a curious property most marked in semi-conductors. This incidental observation was, I believe, forgotten till, in 1873, Edison re-discovered and greatly extended it.

BLOODHOUNDS ON THE TRAIL.

THE drawing opposite, by Mr. Goddard, who has contributed to our journal many spirited representations of animal life, gives an idea of the tremendous energy and intensity of purpose with which bloodhounds of the true breed will pursue their quest, sometimes for many miles, and during several days and nights, if permitted, following the scent of a fugitive man or beast—only a wounded stag, it may be, or an escaped criminal—a slave running from a tyrant master, or a spy in war time lurking near the camp in a hostile country, or any other object of sufficient importance to be worth employing these powerful hunting dogs. The bloodhound, in spite of his terrible name, is not a remarkably cruel and savage animal, but one of the most generous of the canine race; and we have seen him the beloved and affectionate playmate of little children on the parlor hearth-rug, never causing the slightest alarm, and willing to watch baby's cradle for hours together. He is certainly one of the noblest looking of all dogs, as Sir Edwin Landseer's famous picture of "Dignity and Impudence" has taught the world to see; he has a knightly countenance and bearing, like a hero of the Court of Arthur, which commands our sincere respect, and we scarcely think of him as a brute, he seems to be such a perfect gentleman, honorable, grave, and valiant, and the soul of truth. This, however, is the individual character of the bloodhound, as he appears when admitted to human society. The hunting scene represented in our engraving shows four or five of them in the full exercise of their native instincts and faculties, in the open field. They are very likely to come up with their game, whatever it be, after a brief course of further running.—*Illustrated London News.*

BLOODHOUNDS ON THE TRAIL.—DRAWN BY G. B. GODDARD.

A SHORT HISTORY OF SIZING.

By GEORGE WHEWELL, F.I.C., F.C.S.

THE question of sizing and size mixing is just now coming prominently before the trade, and a short history of the subject may be of interest in helping to solve the problem, How to prevent, or reduce to a minimum, the liability of cotton cloth to suffer from mildew? Size is a paste made for the purpose of filling up the interstices in the yarn, and making the outside smooth, so that when it passes through the healds and reed the external fibers will not unite with the external fiber of the adjacent thread, and so be broken in its passage through the healds and reed. In preparing size, care should be taken to have materials as finely divided as possible, otherwise it will make the yarn uneven in passing through the healds and reed, and thus cause breakages.

The following are the chief requisites for a good size:

1st. To be in a very fine state of subdivision.

2nd. When placed upon the yarn it should make the fiber assume a horizontal position.

3rd. The size itself, when upon the yarn, ought to be as homogeneous as possible.

4th. The size ought not to decompose after being used, and so cause the cloth to mildew.

For a great number of years the only substance used in this country for sizing purposes was flour paste. In olden times it was customary for the weaver to size his own warp as it came off the beam, the only substance used being just sufficient flour paste to give the thread the required tenacity to overcome the strain caused in the weaving, for which purpose the Hindoo weaver had among his implements for weaving a water pitcher and rice pot. As the trade extended it was found more advantageous and economical to have the warps sized previous to being sent to the weaver; and it was also found that the sizing being given to a person who made a trade of sizing, the putter-out of warps to be woven had a control over the amount of size, and could increase or diminish it at pleasure. Finding from experience that more size could be put on the warp than was necessary, thus arose the practice of heavy sizing; that is, making cloth, previously consisting almost entirely of cotton, of a mixture of size and yarn. This system of weighting, which began in the latter end of last century, having become recognized by the trade, persons began to cast about for substances to use along with or instead of flour paste. With the new state of things came an increased risk, the heavy-sized goods having a larger quantity of putrefiable substance in them, the tendency to mildew when kept in a warm damp atmosphere increased also.

We find by referring to the records of the Patent Office, numerous applications for letters patent for substances to be used instead of flour paste, in which starch in the various forms takes a prominent position. We also recognize early attempts to counteract mildew. Papping seems to be the ancient name for sizing, for in a specification of a patent by John Barker, Joseph de Mayes, and John Cook, A.D., 1769, No. 937, it is said "that the wool is wound on bobbins, warped, papt, or sized." In 1776, James Wolstenholme, No. 1,123, took out a patent for goods called velveteens. The warp is made of linen in the brown, and the weft cotton. He described different kinds—some cotton instead of linen, bleached and sized. No mention is made of the composition of the size. In 1789, Edmund Cartwright, No. 1,696, says the sizing liquor or dressing is prepared of such glutinous material as is commonly made use of by weavers for that purpose, according to the article they are weaving, evidently referring to flour paste. The first sizing machine recorded is in a patent, No. 1,804, by Richard Gorton, 1791, of a loom intended to weave several pieces at a time. He says the warp is sized by means of brushes and a roller, which turns in a square trough filled with size. In 1794, James Travis, No. 2,003, took out a patent which related to the stiffening of twist or weft cotton, and had for its object using potatoes instead of wheat flour, up to then universally used.

"The potatoes are first washed, put into the grating machine without peeling, and without any mixture or other ingredient whatever. After grating they are washed in fine sieves, the starch falling to the bottom of the cask or tubs; it is then taken out, carefully dried, and cleansed. Quicklime is taken and exposed to the air, until it falls to powder. These two substances are then mixed together in the proportion of one hundredweight of lime to six hundredweight of the floury part of potatoes." This appears to be the first patent taken out to substitute starch (farina) for flour in size, and also to use a substance for weighting, so that it may be said that the practice of weighting cloth arose at this period. No mention is made why the floury part of potatoes was recommended instead of flour paste. Between the years 1794 and 1800, starch seems to have come into use, for we find Robert Stuart's inventions, A.D., 1800, No. 2,377, relates to starching and preparing cotton yarn in that state called the cop, by which means it is at once fitted for being made into warp or weft. The cop is boiled in starch or other mucilaginous liquor. In 1806, Patrick Whytock's invention, No. 2,913, relates to preserving fabrics made of cotton, flax, or hemp, and consists in the application of the oxides, or solution of quicksilver and copper salt to the articles intended to be preserved. The red oxide of mercury is levigated and mixed with starch, which the weaver uses in smoothing his threads; the red oxide being inserted along with the starch into the heart of the cloth tends to defend it from mildew, or acts as an antiseptic. In the same year Quinton McAdam, No. 2,924, mentions starch and flour as used in the process commonly called sizing or papping. The question naturally arises, when in 1794, we find the first mention of the introduction of starch in the sizing of warps, and the recommendation of salts of mercury and copper to prevent mildew in the year 1806, whether mildew had increased with the introduction of starch, or whether it was due to the increase in the amount of size used? It is, however, possible that Whytock was the first who undertook to remedy the evil; but whether his invention came into general use we know not, but it seems to be a fact that mildew was a common complaint about the beginning of the present century.

There is not the slightest doubt but that the increase of putrefiable substance put into the yarn was one of the causes of increase of mildew; but that the introduction of starch had its influence there is good ground for belief, for we know that starch very rapidly mildews when exposed to a warm and moist atmosphere. Between the year 1806 and 1841, no patents were taken out for improvements in the composition of size. In the latter year, J. H. Watson's invention, No. 9,194, consisted in the application of a composition formed by mixing resin and alkali with sulphate of magnesium, and also the application of a composition formed by mixing a combination of tallow or other grease and alkali (which of course would form a soap) with sulphate of magnesium. The next improvement consisted in causing cloth, after a mixture has been applied to it, containing sulphate of magnesia, alum, or other salt whose base is a metallic oxide, to be acted upon by an atmosphere of or containing ammonia gas, to deposit the metallic base on the cloth. The next improvement, a combination of ammonia with lard, tallow, oil, or other grease, was spermaceti or stearine. This is the first mention of the use of sulphate of magnesia, and also the first application of soap for sizing purposes, and the beginning of the general use of water absorbing substances to give weight to cloth, and prevent mildew.*

In 1842, James Anderton's interesting patent, No. 9,255, was to substitute the "farina" in the common process of preparing, stiffening, and dressing yarns or warps for wheaten flour. He says: "I am perfectly aware that the employment of the same article, 'farina,' has already been attempted to be used for such purpose; the novelty being to use it at once instead of allowing it to ferment, by which means its glutinous or stiffening quality is lost." Thus it might safely be said, although starch (farina) was suggested in 1794, starching came into use at the beginning of the present century. Yet in 1842, wheaten flour seems to have had the leading position in the making of size, and starch either to have gone out of use, or only slightly employed.

In 1842, John Ridsdale's improvement, No. 9,482, consisted in preparing fibrous materials for weaving and in sizing warps (no specification). In 1844, J. B. Cotter's invention, No. 10,330, consisted in a composition to be applied to fabrics to render them "impervious" to or repellant of water, and consisted of boiled oil one gallon, white lead one lb., charcoal 26 ozs. in powder, litharge 2½ ozs., and common salt 2½ ozs. In the year 1847, William Todd's invention, No. 11,595, was to place the cop, bobbin, or yarn beam in a cylinder, and exhaust the air. The boiling size was then introduced by a pipe from a trough.

The first patent for the composition of size during the present generation was one taken by J. B. Chalimin in 1851, No. 13,829. He recommends the following: For every four hundredweight of warp, 33 lbs. starch, 32 lbs. wheat flour, 23 lbs. potato starch, 3 ozs. bleached bees'-wax, 2⅜ lbs. sulphate of zinc, and ½ lb. sulphate of copper, to 700 pints of water. The only novelty in the materials of this composition is the bleached bees'-wax and sulphate of zinc, the copper salt appearing in Whytock's specification.

This may be said to be the first of a large number of patents for the composition of size. In the year 1853, Wm. Bashall, Jr.'s invention, No. 641, is for the application of oil, by means of a roller, to the yarn after it has passed through the size box. The composition of the size is not mentioned. John Greenwood and Robert Smith took out three patents in the year 1854. The first, No 373, relates to the employment of the mucilaginous matter of linseed, the seed of the common flax. The second, No. 867, relates to the novel application of the flour or meal obtained from Indian corn or maize, either alone or mixed with the mucilaginous matter of linseed. The third, No. 1,238, relates to the use of rye flour and acetic acid; chloride of calcium, and, for the first time, chloride of magnesium is noticed. 240 lbs. rye flour, half the usual quantity of water, six or seven quarts of acetic acid at 9 degs. Twaddell; the other half is made up with chloride of calcium or chloride of magnesium liquor, at 40 degs. Twaddell, and well boiled. In the same year, John Ashworth's invention, No. 2,012, relates to the application of the following composition: 35 lbs. of glue substitute, 60 lbs. of Castille or any other soap, 20 lbs. of salt or saltpetre, 5 lbs. of isinglass, and 20 lbs. of ordinary wheat starch. In 1855, John Greenwood's invention, No. 101, consists, first, in the use of barley flour; second, barley flour combined with chloride of calcium or chloride of magnesium. The barley flour may be used either fermented or not; in the latter case three or four quarts of acetic acid, 9 degs. Twaddle, is to be added. In 1856, Jean Louis Ambroise Huillard's improvement No. 214, consists in the employment of metallic cyanides—preferably the cyanides of zinc and tin, instead of gum, starch, etc.—the cyanide being fixed on the yarn by passing it over a vessel in which superheated steam circulates, whereby the metallic dressing becomes oxidized. In the same year, Peter and George Brown, No. 693, claim the use of a seed or grain called "dari," and frequently called "millet," which was prepared in a similar manner to rice. In the same year, John Leigh, No. 838, proposed the use of alkaline silicates, as potash, soda, etc., either alone or mixed with sulphate of baryta; tallow, soap, etc., may also be used.

Here we discover the second patent for the use of weighting substances, the first being hydrated lime, proposed by Travis, in 1794. In the same year, 1856, Auguste Cellier's invention, No. 2,817, relates to the application of a preparation of lichens and pearl moss. And this reminds us of the recent attempted introduction of a substance manufactured in France, and called by the name of *Haitra*, or *Hai-thao*, which, according to J. J. Heilmann, *Dingl. Polyt. J.*, ccxviii., 522, is obtained from an algæ, occurring abundantly in Cochin China and in the Mauritius, in the form of coarse, flat fibers, which, when hard and tough, are about 30 in. long. It is without smell or taste, and consists of a transparent colorless mass, covered with a net of non-transparent veins. It is insoluble in cold water, and dissolves completely in hot water, but only after boiling for ten minutes, forming a transparent, thin, dirty white jelly, soluble on boiling. The jelly is neither acid nor alkaline, and does not show any signs of fermentation or putrefaction, even when kept for about eight days. Heilmann concludes from his experiments that it can only be used for fine textures, soft and firm to the touch, and that it cannot be used as a substitute for dextrine or potato starch, where a strong and stiff material is required. The tendency since 1842 seems to have been to substitute substances containing less gluten and more starch for wheaten flour.—*Textile Manufacturer.*

GELATINE PLATES IN INDIA.

By Col. F. DAWSON.

DURING the past twelve months I have experimented upon gelatine plates and pellicle, and thinking my notes may be of use to others, I take the liberty of jotting them down.

It is quite possible to develop plates with the liquids used at the temperature of 85° Fah.

It is quite easy to make your own dry pellicle without setting the jelly or using ice.

TO MAKE PELLICLE.

Nelson's gelatine	250 grains.
Brom. potassium	200 "
Distilled water	5 ounces.

Use pounded and dried bromide, weigh carefully, and dissolve in 4 ounces of the water; now weigh the gelatine, and place in a yellow hock bottle; filter the bromide into the bottle, and wash out the filter with the remaining ounce of water.

Allow the gelatine to soak for two hours, when it should be quite swollen and soft. Now have a large saucepanful of nearly boiling water, dip the bottle into the hot water quickly for a second, continue the dipping until there is no fear of the bottle breaking and it becomes as hot as the water, shake up, and ascertain that the gelatine is quite dissolved.

Melt 280 grains fused nitrate of silver in 2 ounces of distilled water, filter, and wash out the filter with 1 ounce of distilled water. Place this clear solution in a small bottle in the hot water until warm.

Now add the silver solution to the gelatine in small quantities, not exceeding 10 minims at a time, with violent shaking after each addition; when the whole of the silver is added, shake up for five minutes, and place the bottle in the hot water; give occasional shaking at intervals of a quarter of an hour for two hours, then leave the bottle in the hot water for at least four hours longer (occasional shaking is an advantage); at the end of these six hours the water will have cooled to 85° or 90° Fah., about the temperature of the atmosphere.

Now remove the bottle, and into it pour, by an ounce at a time:

Methylated absolute alcohol	6 ounces.
Methylated spirit	6 "

(The spirits must be free from gum.)

Shake up violently after each addition of the spirits, and continue adding at intervals of a few minutes, until the gelatine begins to precipitate upon the sides of the bottle; when this is observed, add an extra ounce or two, according to available space in the bottle, shake up violently, and leave standing in the dark room for two or more hours. One hour may be found to be sufficient; the appearance of the fluid in the bottle should be your guide.

If, upon pouring a small quantity into a minim measure, it appears thick and very milky, either sufficient time has not elapsed, or your spirits are too weak, or you have not used enough. As a rule, two ounces of the mixed spirits are enough to abstract 1 ounce of water known to be used in the formula.

If the liquid in the minim measure is merely opalescent, you may with confidence pour out the whole of the fluid. If, after the fluid has stood for two hours, the gelatine has not separated, you have made some mistake.

When the pellicle has precipitated, pour off the fluid and drain the bottle; now pour into the bottle 2 ounces distilled water, place in hot water and remelt the gelatine, pour out as much as possible into a clean glass dish, and remove the surplus adhering to the bottle by additions of 1 ounce distilled water at a time; 2 separate ounces I find quite sufficient. With a glass rod mix the gelatine in the dish, and then with one hand stir up, and with the other slowly pour in 2 ounces of spirit (same strength as before) for every 1 ounce of water you have used in redissolving the pellicle.

Almost immediately the gelatine will stick to the glass rod, and also to the bottom of the dish; continue stirring until the whole of the pellicle is collected in a lump on the glass and a part smeared over the dish, but with the spirit only slightly opalescent; when this is the case throw off the spirit and drain the dish, then pour into the dish an ounce or two absolute alcohol, and knead with your fingers the pulpy mass of gelatine; scrape up all you can from the dish with an ivory knife; after a few minutes you will find the gelatine getting tougher and tougher; pull it into bits and keep it well wetted with spirit; it will not adhere to the fingers. When the pellicle becomes about as tough as a piece of India-rubber of a similar size, drain the dish; give the pellicle a squeeze in a clean pocket handkerchief or towel, and proceed to tear it into very small bits; now place the dish containing the bits on a tin dish of hot water or other means of applying heat by water. As time passes inspect your pellicle; you will find the outside gets hard, while the inside remains soft; when this is the case, tear the bits into smaller bits, and continue the drying and tearing until the pellicle is as dry as it is possible to make it. Then place it in a stoppered bottle and keep in the dark.

The fused nitrate of silver is simply crystallized silver brought to melting in a small capsule.

I have used pure spirits with similar results. Crystallized silver may be used without fusing.

FOR USE.

Dry pellicle	2 drachms.
Distilled water	3 ounces.
Spirits of wine	1 drachm.

Allow the above to soak for a couple of hours in a 6-ounce stoppered bottle, then warm in a mug of hot water; shake up well until the ingredients are thoroughly incorporated, and filter.

The above quantity will coat 18 plates 8 by 5.

TO PREPARE THE PLATES.

Obtain a 2-ounce glass filter; round the nose tie muslin four thicknesses, and clip.

Next obtain a 4-ounce cometless collodion pourer. Remove the pourer, and into it plug a thin piece of sponge, sufficiently thin to permit the gelatine to flow through it and stop bubbles.

Damp the sponge before use. Filter the gelatine into the collodion bottle, and replace the pourer. Place the filter in the stock bottle, and stand it in a tin pot of hot water. In another tin pot of hot water stand the collodion pourer containing the gelatine. Have ready some pieces of plate glass carefully levelled on a table and capable of holding 18 plates 8 by 5; also have ready some means of warming the plates—a spirit lamp or a tin water bath. Warm each plate sufficiently, about as warm as you would when varnishing a negative, rather under than over. Now pour the gelatine on to the plate exactly as you would collodion, let it run all over the plate, and then pour off into the filter, while you count three in quick time.

Remove any surplus from the corner of back of the plate by passing the finger over the spot, and at once place the plate down on the levelled plate glass. The plates will take about one hour to prepare, and will be perfectly dry in four hours; some, of course, will be dry before others. The candle may with impunity be nine feet from the plates you are preparing the plates. Plates prepared by the above formula are at least as sensitive as wet collodion, and I find no signs of fogging from the candlelight. The color of the film is a deep ruby. The films should be fairly thick, but not too thick. If, in using the amount here named, you can prepare 18 plates 8 by 5, you may anticipate they are correct. If the

* It appears to us our contributor has made a slip of the pen here. There is no reason *per se* why deliquescent substances should be antiseptics.

plates are much longer in drying than four hours, you may conclude they are too thick, especially if you have not one dozen and a half.

One drachm of alcohol is quite enough for three ounces of water; more has a tendency (as pointed out to me by Mr. Kennett) to drive the gelatine too much towards the edge of the plate, and I also find that much more than one drachm causes the film to dry in waves of unequal thickness, with a watered-silk like appearance on the surface.

The plates must be perfectly dry before placing in plate-box or holder. I have not found backing of the least good in preventing blurring. If the subject is carefully selected, and the films are fairly thick, I do not find any tendency to blurring. If the gelatine is poured on to the glass in sufficient quantity, it will run like collodion. If you do not pour on enough gelatine, the chances are it will not run all over the plate, but have a desire to go its own way; in this case freely use the finger to guide it, but be careful not to place the finger on and touching the glass; keep the finger in the gelatine, and on all occasions of using the finger be careful not to remove it from the gelatine until you have brought it to the edge of the plate and towards that side whence you intend to pour off. Bubbles are most difficult to see and remove: be careful to avoid making them.

Holding the plate after coating for any time will result in the gelatine being repelled in the neighborhood of the fingers.

TO EXPOSE AND DEVELOP.

I find that success mainly depends on correct exposure. Where there are great contrasts from very bright light, you must give a longer exposure than when the picture is not so brightly lighted, otherwise you will have chalky whites and black shadows. A good negative is a very poor thing to look at in point of density. If it is in appearance approaching the density of even a weak collodion negative it is useless; it should have the appearance of a greenish looking transparency. The time of exposure may be for ordinary landscapes from three to fifteen seconds. I have not myself succeeded with long exposures, except when using Kennett's slow plates; these will stand many minutes' exposure, and without a sign of blurring.

DEVELOPMENT.

Place the exposed plate in a dish, and dash over its surface two ounces of filtered pyrogallic, 4 grains to 1 ounce of distilled water, into the glass. Measure; pour two drachms of the following:

Brom. potassium	23 grains.
Liq. ammonia fort.	30 mins.
Distilled water	2 ounces.

Pour off the pyro on to this mixture in the measure, and as quickly as possible pour on to the plate in the dish. The image starts out at once, and in five to ten seconds the development is complete. The appearance of the negative at this stage is very deceptive; it should not look fogged, but with this exception very little idea of what the negative will be is obtained. Have ready your hypo, one ounce dissolved in four ounces common water. Pour off your pyro developer, and at once pour on the hypo, being careful not to pour it on to the plate, but pouring freely and flooding it over quickly. Be careful to keep the plate in the dark until perfectly fixed, or there will be stains. It is quite impossible to fix a negative without stains if it be taken to the light before fixing.

The secret of being able to work with all the solutions at upwards of 80° depends upon having everything ready and working quickly. Immediately the negative is perfectly fixed, remove it, and, holding it by the corners, place downwards. Place it in a basin of water as cold as you can procure it, move it very gently for about ten seconds, change the water, again wash for ten seconds, and leave up on a corner to dry.

If care has been used, there will be no frilling or blistering, and the negative will be dry in half an hour or so in the open air—not, of course, in the sun. I have tried using spirits to draw out the water before the plate is reared up to dry. I have not been successful; unless the spirits of wine be very cold (artificially cold), the image seems to be raised in relief by the action of the spirit upon the film.

I have never varnished a negative; it may be necessary in a climate where the air is charged with moisture, but I have no experience with such a climate.

Kennett's pellicle is better in every way than what I make, but when you have not a stock of Kennett, it is as well to know how to manage, however indifferently, without it. With a packet of Kennett's sensitized pellicle, and 340 grains Liverpool dry collodion pellicle, I would go anywhere and undertake to take any description of landscape I have met in India.

In conclusion, I beg to assure you that I do not wish it to be understood that I recommend the above preparations to the detriment of other manufacturers, but simply because I have extended experience with them, and none whatever with any other.

The amount of pellicle resulting from the formula I have given, allowing for waste, etc., should be enough to coat at least six dozen plates 8 by 5.—*Photographic News.*

PROCESS FOR PRINTING OR TRANSFERRING DESIGNS.

By L. ZWEIG and A. T. TISCHLER, of Vienna.

IN order to produce matrices or engravings for prints in an economical manner, it is proposed to employ peculiar metal positive prints of the designs to be copied, which are to be obtained by producing at first in low relief work the design to be copied on a zinc plate by etching the latter by galvanic action. For this purpose the zinc plate to be etched is covered with a body color or coating in which the design to be transferred is traced by means of a tracer or graver, and the plate thus prepared is then used as a positive electrode in a galvanic decomposing cell. A second zinc plate, of the same size as the plate to be etched, and serving as the negative electrode, will be placed together with positive plate, but at a proper distance from it in the decomposing cell.

After the galvanic current has sufficiently operated upon the zinc plate, which is placed in a solution of sulphate of zinc mixed with sulphuric acid, the etched plate is to be taken out of the decomposing cell, and washed in a bath of potash or soda lye, in order to remove the remainder of the body color. But the fact that all the engravings appear to be of the same depth is prejudicial to the clearness and sharpness of the transfer of the designs from a flexible printing plate or surface, produced by the aid of the etched plate, since besides the fine raised parts, some parts also of the ground which are not intended for printing may be transferred or reproduced. To obviate this objection it is necessary to clean the zinc plate with a rag, to dry it off, and then to cover entirely all the low etched places with a mass or composition, such as is used for printing rollers, and composed chiefly of glue, glycerine, and syrup, by which operation the plate becomes perfectly even and plain. This is done for the purpose of preventing the tin from entering into the low etched places during the process of soldering. After this the widely veined parts must be more or less heightened with tin to the effect that they may appear deepened or recessed in the matrix, and that the blank or unveined places cannot be printed at once when the designs are transferred upon wood. The composition is then removed by putting the plate in warm water and the parts thereby dissolved are made even with a scraper. From the metal plate thus prepared, the printing matrices are obtained in the following manner.

The zinc plate is placed on the hollow bottom plate of a powerful press, which plate can be heated by steam and cooled by cold water. The composition, to which the required softness is imparted by adding some solution of hygroscopic salt, such as chloride of calcium, chloride of zinc, or chloride of aluminum, is poured upon the oiled zinc plate, and the upper pressing plate, covered with a piece of linen of the same size as the zinc plate, is pressed down. The lower pressing plate, which must be perfectly plain and even, in order to enable the zinc plate to bed evenly and equally in all parts, is provided on its four sides with raised borders of the height of between 1-16th to 1/24th of an inch, by which the thickness of composition to be pressed upon the linen fabric will be regulated, the pressure of the upper pressing plate causing any surplus quantity to be squeezed out. During the time the upper pressing plate is being pressed down, cold water is caused to flow through the bottom plate, whereby the setting or solidifying of the composition adhering to the linen fabric is much expedited. The linen, together with the composition firmly adhering thereto, and representing in relief the sun parts in the zinc plate, discharges itself from the composition, and a matrix is thus obtained which is to be coated with a caoutchouc varnish; in order to render the matrix more resistable.

The matrix is now ready for producing prints. The prints of relief designs will be made in the following way. The matrix is passed over by inking rollers coated with any desired color, and is then gently pressed against the surface to be decorated, whether of wood, paper, or plastered wall surfaces, by means of a brush, and finally carefully removed from the surface. The designs now appear to be transferred on to the grounded or prepared surface; and for the purpose of fixing them nothing further is required than to varnish them as is done in hand work.

THE NEWEST EXPLOSIVE.

GUN-COTTON and dynamite, which have for some years past held the foremost rank among modern explosives, are no longer, it seems, to retain this honor undisputed. A compound more violent still than either of these well-known preparations has lately been given to the world by M. Nobel, in the shape of blasting-gelatine, and blasting-gelatine, again, has been endowed with still greater energy by a modification in its nature, effected by Prof. Abel, the War Department chemist. So far as experiment has shown, the gelatine and modified gelatine are, without doubt, the most active explosive agents known to us, or, in other words, a given weight of these compounds will work more destruction upon metal, stone, or other unyielding mass, than any of the hundred and one bodies of a like character with which we have become acquainted during the past half-century.

It is a well-known circumstance that, with but very few exceptions, the many explosives that have lately been brought before the public under a variety of names are merely modifications of one and the same thing. They are all nitro-compounds, or modifications of them. One class owe their origin to gun-cotton and the other to nitro-glycerine, and gun-cotton and nitro-glycerine are by the chemist regarded as the same thing. Gun-cotton is made by the nitrification of a solid body, and nitro-glycerine by the nitrification of a liquid body. The methods of manufacture are similar, and the agents employed to bring about the nitrification are the same. In the one instance a woody fiber—cellulose—is acted upon by a mixture of strong nitric acid and sulphuric acid, the former liquid to perform the operation of nitrification, by substituting certain equivalents of nitrogen for the hydrogen existing in the cellulose, and the latter acid for the purpose of absorbing any moisture given off in the substitution process, and thus preventing the nitric acid from becoming dilute and inefficient. In the other, a liquid—glycerine—is permitted to combine in small quantities at a time with a mixture of the same acids, and in like manner parts with its hydrogen, to be replaced by nitrogen.

There is, however, this wide difference in the application of the two compounds. Gun-cotton may be employed as it stands, and the Abel gun-cotton that is used by our soldiers and sailors for torpedoes and mining work is simply a pure pyroxiline, pulped fine to permit of its being thoroughly washed, and compressed into *papier-mache* sort of blocks, for the sake of convenience. Nitro-glycerine, on the other hand, being a liquid, is difficult to handle in that form, and for this reason it is that Nobel and others cast about for suitable vehicles to contain the preparation. A siliceous clay called Kieselguhr, which will absorb three times its weight of the liquid, has been found the most favorable substance, and dynamite, generally speaking, may be said to consist of 75 per cent. of nitro-glycerine and 25 per cent. of this inert substance. In lithofracteur, other substances, besides, are employed, such as powdered charcoal and niter, and there now exist a whole family of such combinations, none of which contain, however, more than 75 per cent. of the active explosive, nitro-glycerine.

In blasting gelatine, which, by the way, contains no gelatine at all, the objection to employing an inert material is got rid of altogether, and the mass, like compressed gun-cotton, is explosive and combustible throughout. Blasting, or explosive, gelatine is a mixture of nitro-glycerine and gun-cotton. M. Nobel, to whom is due the credit of having placed the valuable properties of nitro-glycerine at the disposal of mining-engineers, has discovered, in the pursuance of further investigations, that the liquid in question acts as a solvent upon gun-cotton. Like a mixture of alcohol and ether, nitro-glycerine is found to dissolve nitro-cellulose, and form a description of collodion, or, as M. Nobel terms it, gelatine. It is not, of course, the highly-explosive gun-cotton that will thus dissolve, but that known as photographer's pyroxiline, which does not contain so much nitrogen. Military gun-cotton, indeed, or tri-nitro-cellulose, to call it by its chemical name, should not be soluble at all, or at any rate only to a slight extent, if properly manufactured, and one of the tests to ascertain if it is of good quality is in fact to treat it with an alcohol-ether mixture to ascertain how far it will dissolve. The soluble gun-cotton, however, if not so highly nitrified, to coin a term for our purpose, is still a sufficiently explosive body, and this M. Nobel finds he can dissolve to a greater extent in nitro-glycerine than it is possible to do in alcohol and ether. Whereas the latter will dissolve no more than four or five per cent. of pyroxiline, and frequently less than two, nitro-glycerine has been found to take up upwards of seven per cent. The operation of dissolving is presumably done when the liquid is warm, and the result is, as we have said, a jellified mass, which has all the attributes of a definite combination. There is no separation of liquid from the mass, and cartridges may be made by simply rolling up the material in paper envelopes.

Thus, in blasting gelatine, there is no inert body, and the consequence is that, weight for weight, the gelatine is superior in its destructive action to dynamite. The latter, as we have seen, contains 75 per cent. of nitro-glycerine, whereas blasting gelatine consists of from 90 to 93 per cent. of this liquid, and from 7 to 10 per cent. of soluble gun-cotton. But there exists another reason still why the detonation of blasting gelatine should be more energetic, namely, because the combustion of the charge, from more perfect oxidation, is well nigh perfect. Prof. Abel pointed this out very clearly in his recent lecture at the Royal Institution. "As nitro-glycerine," he said, "contains a small amount of oxygen in excess of that required for the perfect oxidation of its carbon and hydrogen constituents, while the soluble gun-cotton is deficient in the requisite oxygen for its complete transformation into thoroughly oxidized products, the result of an incorporation of the latter in small proportions with nitro-glycerine, is the production of an explosive agent, which contains the proportion of oxygen requisite for the development of the maximum of chemical energy by the complete burning of the carbon and hydrogen; and hence," Prof. Abel concludes, "blasting gelatine should, theoretically, be even slightly more powerful as an explosive agent than pure nitro-glycerine."

By converting the gelatine into a more solid body, by the addition to it of some 10 per cent. of military gun-cotton, or tri-nitro-cellulose, Mr. Abel appears to have secured a still more vigorous explosive, and one besides that, by reason of its firmness, is more convenient to handle than the softer and pliant jelly. The destructive action of this modified gelatine upon iron plates and heavy masses of lead, has been found greater than that of any other form of nitro-glycerine or gun-cotton, and there is no room for doubt that for torpedoes and military mining, where the object is to secure the greatest degree of violence, regardless of consequences, the compound will find valuable application.

While on the subject of nitro-glycerine and its behavior as a detonating agent, a few words may be said upon the report of the Chief Inspector of Explosives that has just been issued by the Home Office. If only because it controverts a popular notion as to the dangers of this substance in a frozen state, the report in question is of considerable interest. Ever since the disastrous accident at Newcastle-upon-Tyne, when Mr. Mawson, the mayor of the city, and several others lost their lives through the explosion of some packages supposed to have contained frozen nitro-glycerine, a wholesome dread of this substance has been entertained. But, strange to say, Major Majendie and Mr. E. O. Brown, of Woolwich, who appear to have been associated with the chief inspector in these experiments with frozen nitro-glycerine, found the latter far less sensitive either to blows or to fulminate powder than when in its ordinary condition. In some cases the frozen material allowed itself to be scattered by the violence used, without detonating at all, and it was only by using a very large charge of fulminate powder that its explosion succeeded. Frozen dynamite was still more obstinate, and under some circumstances, indeed, its detonation appeared almost impossible. Another circumstance of an unexpected character presented itself in these experiments. Mr. Brown found that the solidification of nitro-glycerine—a phenomenon that usually happens very readily some degrees above the freezing-point of water—is particularly difficult to bring about when the liquid is in a pure state. Continued subjection of the pure liquid to a temperature below freezing-point failed altogether to effect its solidification, and it was only upon the addition of a few grains of a solid body that the desired result was secured. The reason, therefore, why commercial nitro-glycerine so readily solidifies at a comparatively high temperature is obviously because it is not perfectly pure.—*H. Baden Pritchard, in Nature.*

ANTHRACENE ($C_{14}H_{10}$).

THIS substance, which has become of such great importance in consequence of Graebe and Liebermann's discovery that it can be converted into alizarine, was discovered by Dumas and Laurent in 1832. They gave it the name of paranaphthalene. For nearly forty years it remained a mere chemical curiosity, and now it is one of the most important of the coal-tar products. Its formula is $C_{14}H_{10}$. It boils at about 360° C. = 680° Fahr., and it melts at 213° C. = 415° Fahr. Its boiling point shows at once that it is one of the least volatile of the products obtained in the distillation of tar.

According to Auerbach,* who is, perhaps, the highest authority on the subject, anthracene is not contained, as such, in coal tar; but is produced by the splitting up, during distillation, of a more complex hydrocarbon, probably of the formula, nC_7H_6.

There are two processes by which anthracene may be prepared by the tar distiller; but it must be remembered that, as at first obtained, it is in an exceedingly impure condition. The two processes to which we allude are—firstly, to push the distillation of green tar to the point at which anthracene is formed and comes over, and the second is to distil soft pitch.

Separation of Anthracene from Green Tar.—We have so minutely described the various methods of distilling tar and heavy oils, that the attentive reader will have no difficulty in following the directions to be given. We have stated that when tar is distilled over the naked fire, two points are reached when the product distilling deposits a solid on a glass plate. The first is the naphthalene stage; at the second one, the substance contains anthracene. There are advantages, especially if the weather be cold, in allowing the distilate to remain in tanks for some time—in fact, as long as may be convenient—to allow the anthracene, which is dissolved in the accompanying oils, to crystallize out. It is

* "Anthracen," by G. Auerbach; translated by William Crookes. London: Longmans. 1877.

obvious, however, that the period of repose must not be allowed to reach the time of hot weather.

When it is believed that the anthracene has settled out as much as it will, it is to be introduced into a hydro-extractor or centrifugal machine, to remove, as far as possible, the oily impurities. The centrifugal machine, however well worked, still leaves much oil. It frequently happens that the crude anthracene is so soft as to pass through the lining of the machinery; in which case, a filter-press, such as Dehne's or Needham & Kite's, may be employed with advantage. Before being pumped into the press, the crude anthracene must be warmed to 40° C. = 104° F.

In either case, it must afterwards be subjected to the hydraulic press, preferably one which has iron plates capable of being warmed. Gessert (*Ding. Polyt. J.*, cxcvi. 543) prepares anthracene containing 95 per cent. of real anthracene as follows: He takes the "green grease"—*i. e.*, the portion of the distillate from tar which comes over at the second solidifying stage—and removes the adhering oil by a centrifugal machine. He then heats it to 40° C. = 104 F., and subjects it to hydraulic pressure, or sends it through a filter press. The compressed cake, which contains about 60 per cent. of real anthracene, is boiled out with coal or petroleum naphtha; it is then again passed through the filter press, and the cakes are finally fused.

Calvert states that the cake, when hot-pressed, contains 70 per cent. of anthracene; but if cold-pressed, only 40 per cent. As the liquid which comes away during the process of hot-pressing contains some anthracene, it is proper to store it again as long as possible, in order to let it deposit. A good plan is to run it into tanks, and, when the creosote oils are required, to leave the thick at the bottom, and again fill up with the "press oil." After a time the tank can be emptied, and the thick portion be put through the filter press.

Preparation of Anthracene from Soft Pitch.—The first persons, as far as the writer's knowledge extends, to prepare crude anthracene from soft pitch, on the large scale, were Messrs. George Miller & Co., tar distillers, of Glasgow. In the course of some important experiments which they were conducting, more than 20 years ago, upon lubricating oils, they pushed the distillation of boiled tar until the orange vapor, which, as we have said, contains chrysene, pyrene, and other substances, came over freely. They then introduced the semi solid products into an open iron pot, set in brickwork in a moderate sized room. The fireplace opened outside, so that there was no danger of explosion. The pot was then heated, until it was considered that all volatile products had been sublimed into the room. The writer happened to be present when the door was opened, and a truly extraordinary sight presented itself. The floor, the roof, and the sides of the room were covered with a thick layer of a crystalline yellow powder. Messrs. George Miller & Co. most kindly presented the writer with a keg of this powder for examination. Circumstances connected with the pressure of other investigations rendered it impossible for him to commence working upon it at once; he therefore gave the powder to Dr. Anderson, who at once entered upon its study. He soon found its principal ingredient to be Laurent's anthracene, and discovered an easy method of preparing oxyanthracene, the anthracenuse of Laurent, and anthraquinone of Graebe and Liebermann.

Dr. Anderson undoubtedly, therefore, takes an important place on the roll of those discoverers whose researches have led, step by step, to the artificial production of alizarine from coal tar.

Kopp directs that the distillation of the tar is only to be pushed to the point which we have indicated in describing what we have termed the "English system," where the naphthalene stage has been succeeded by heavy oils, which do not solidify on the glass plate. The residue in the still is, at this stage, what is termed soft pitch. The latter is then to be transferred to a shallow still. The head of the latter must be wide, and reach within eight inches of the surface of the pitch in the still. As we have mentioned, in describing the "French system," the water in the worm tube is to be hot at the commencement of the distillation, and afterwards it is to be kept boiling. This is, of course, to prevent the vapors from solidifying and stopping up the tubes. The exit of the heavy, and therefore sluggish vapors, is to be assisted by a current of superheated steam or air deoxygenized by passing through a red-hot tube filled with charcoal. We unhesitatingly prefer the former.

The still is so arranged that the level of the pitch can be kept almost constant. For this purpose, a vertical tube of convenient diameter passes through the dome of the still down into the pitch to half its depth. It must have an arrangement for opening or closing at its upper end. By means of a "dip stick" the level of the pitch in the still can always be ascertained, and more added as desired.

Care must be taken that too much of the orange vapors, to which we have so frequently alluded, is not allowed to pass over, as they greatly interfere with subsequent purification of the anthracene.

The preparation of anthracene from pitch, by carrying the distillation so far as to leave nothing but coke in the still, has engaged the attention of several chemists. Versmann, Ferner, Greiff, and others, have occupied themselves with this question; but, as pitch anthracene contains much chrysene and other substances very difficult to remove, it is looked upon in commerce with disfavor; it will not, therefore, be necessary, in this short sketch, to describe their processes.

Purification of Crude Anthracene.—The anthracene prepared as above is exceedingly impure. It is to be distilled in a current of superheated steam until chrysene and pyrene make their appearance. The anthracene towards the end appears as a crystalline powder.

When the distillation is finished, the product should, as we have said when dealing with it in the earlier stage of the manufacture, be allowed to repose. It may then be passed through a filter press, and the cakes so obtained be hot-pressed. The temperature of the plates may be a few degrees higher than we advised with crude anthracene from green tar. The press oils are to be treated as directed in the previous case.

The hot-pressed cakes are then to be finely pulverized, and treated with the medium oils we have described under the "French system." If the crude anthracene contains 25 per cent. of real, it is treated thus: The anthracene and about a quarter of its weight of medium oils are put into cylinders with agitators; the latter are rotated for 24 hours. The mixture is then put through a filter press, which will allow of all the naphtha being removed. The cakes are treated in the hydraulic press. It should now contain about 30 per cent. of anthracene.

Anthracene which contains from 25 to 30 per cent. of real is to be ground to an impalpable powder, and treated, as before, with its own weight of naphtha in the cold for 24 hours. It is then to be passed through the filter press, and the naphtha removed. It is then once more pressed to the utmost in the hydraulic press.

The anthracene, as thus purified, is finally to be sublimed in a current of superheated steam.

Determination of the Value of Anthracene.—A vast number of processes for the determination of the value of crude anthracene have been published at various times. Auerbach (*loc. cit.*) has examined all the proposed processes with great care, and comes to the unhesitating conclusion that Luck's method is the only one reliable. The following is an outline of it: Luck finds that pure anthracene yields almost exactly the theoretical amount of anthraquinone when dissolved in glacial acetic acid, and boiled with three or four parts of chromic acid; instead of 100, he obtained 99·4 per cent. When 0·447 gramme of anthraquinone was dissolved in glacial acetic acid, and three or four parts of chromic acid were added, and the mixture was boiled gently for two hours, on dilution with water, 0·446 gramme was obtained. This is equal to 99·89 per cent., and shows that, under the conditions given, anthraquinone is unacted on.

The compounds which come over in distillation along with anthracene, such as chrysene, pyrene, etc., on sufficient treatment with chromic acid, are all converted into bodies soluble in alkalies; they can, therefore, be readily separated from anthraquinone.

Upon these facts Luck founded the following process for determining the purity of anthracene by converting it into anthraquinone:

One gramme of the anthracene to be tried is to be dissolved by boiling it with 45 cubic centimeters of glacial acetic acid in a small flask. It is filtered, if necessary, while boiling hot, through a small filter, and a solution of 10 grammes of chromic acid, in 5 c.c. water, and 5 c.c. glacial acetic acid is gradually added in small portions, keeping the liquid boiling gently. This is continued until a greenish-yellow color appears, or until a drop of the liquid being let fall upon a silver coin, produces, after a few minutes, a reddish spot of chromate of silver. This, of course, indicates the presence of excess of chromic acid, and, therefore, that all impurities have been destroyed.

The liquid is cooled, diluted with 150 c.c. water, and, after a few hours, is filtered. The substance on the filter is anthraquinone, which is washed first with water, then with hot very dilute potash solution, then with water again, and dried at 100° C. = 212° F. The anthraquinone is then removed from the filter, and the latter weighed again. The difference in the weight is that of the anthraquinone.

Dr. Auerbach, writing for professional chemists, did not think it necessary to state that a filter-paper dried must always be weighed in a closed vessel. A very wide glass test-tube, closed with a cork or glass stopper, will serve the purpose, large watch-glasses ground together, and held by a brass clip, are also very convenient. To the weight obtained, 0·01 gramme is added, because that amount remains in the solution.

Commercial chromic acid often contains lead. In this case, the anthraquinone, after the washing with dilute potash solution, must be treated with a hot solution of acetate of ammonia.

In spite of what has been said about the accuracy of this process, it was found in practice that a part of the impurities sometimes escaped oxidation, and were, consequently, estimated as anthraquinone, and the results came out too high. Luck, therefore, improved his method, and, after the treatment of the anthraquinone with alkali, washed it with a washing bottle, into a beaker. The solution, rendered slightly alkaline, was made to boil. A solution of permanganate of potash was then added, drop by drop, until the solution became red. A little oxalic acid and sulphuric acid were then added, to reduce the excess of permanganate, and to dissolve the peroxide of manganese. It was then filtered through the same filter, washed with water until the acid reaction had disappeared, then with very dilute boiling solution of caustic soda, and finally with water. It was then dried at 100° C., and weighed with the precautions above given.

Luck states that although many samples of anthracene require 15 grms. of chromic acid, in general 10 grms. may suffice. Dr. Auerbach remarks upon this, that "this leaving open the amount of chromic acid to be used leads often to very unpleasant results. Thus, *e. g.*, a crude anthracene was oxidized with 10 grms. of chromic acid, and the result obtained in four analyses was each time 26 per cent., whilst the same anthracene, on treatment with 15 grms. of chromic acid, gave in six analyses 23 per cent. of anthracene, and in both cases chromic acid was present in excess. It seems that a slight excess of chromic acid has no longer an oxidizing action upon the anthracene in presence of the acetate of chrome, and that a larger excess of chromic acid completes the reaction."

From what has been said, it is plain that 15 grammes of chromic acid should be used. Luck's process, with the precautions given, is the only method now in use.

Those who wish for a full account of anthracene and anthraquinone are referred to Auerbach's exhaustive treatise previously mentioned. It must, however, be understood that almost all anthracene manufacturers have processes of their own, which differ rather in detail than in principle from those given above.—*Journal of Gas Lighting.*

TOLUIDINE (C_7H_9N).

This alkaloid, also called amidotoluene, was discovered in 1845 by Muspratt and Hofmann, or, rather, it would be more correct to say that they discovered one of its modifications, now known as paratoluidine. Modern researches have shown that there are three modifications of toluidine—namely, paratoluidine, orthotoluidine, and metatoluidine.

Paratoluidine.—This form boils at about 198° C. = 388° Fahr., according to some of the latest researches. Beilstein and Kuhlberg at one time considered it to boil at as high a temperature as 200° C. = 392° Fahr., and that number agrees with a recent determination made by Dr. Otto N. Witt. The mean of three experiments made by the writer upon a product apparently pure gave 198·70 C. Its melting point, according to the authors above quoted, is 45° C. = 113° Fahr. The melting point of its acetyl derivative is 145° C. = 293° Fahr. It gives no colored reaction with chloride of lime and hydrochloric acid.

The literature on the subject of the toluidines is now getting rather formidable, and the writer has not found it an easy task to write a *précis* on the subject which should have the advantages of brevity and clearness. The fact is that the toluidines are becoming more important every day, and it is absolutely necessary that the tar distiller should have a distinct idea of the differences in their reactions and the methods by which they are prepared.

There are two principal ways in which paratoluidine may be prepared—(1) by the reduction of nitrotoluene directly for the purpose; and (2) by fractionation of the so-called heavy commercial anilines.

Preparation of paratoluidine directly.—Toluene, boiling as near 111° C. = 231·8° Fahr. as possible, is first to be converted into nitrotoluene. For this purpose Dr. Hugo Müller mixes the nitric and sulphuric acids, and runs the mixture slowly into the toluene, taking care that the action does not become too energetic, as, in that case, dinitrotoluene would be formed. The nitrotoluene, after washing, is to be reduced with iron fillings and acetic acid in a similar manner to nitrobenzene, as previously described. The crystals of paratoluidine obtained in this manner may be freed from the adhering orthotoluidine by a washing with that portion of American petroleum or Burmese naphtha which boils between 80° and 100° C. = 176° and 212° Fahr. It is then to be re-crystallized from the same menstruum.

Paratoluidine may also be obtained directly by the reduction of the pure solid paranitrotoluene.

We have recommended that when commercial aniline is rectified in cast-iron stills, the operation should not be pushed to dryness, as, in that case, the stills soon become injured. The portions remaining behind, known as "heavy aniline," "aniline residues," "tailings," and in France as "*queues d'aniline*," may either be mixed with the aniline for red, or be treated for the preparation of the different toluidines. Paratoluidine may be prepared from these residues by the following process: The fluid is to be fractionally distilled to separate those portions which boil at or near the boiling point of the toluidines, remembering that if the rectifications are insufficient, much trouble will be found in the subsequent operations, owing to the presence of the other bases, which we have already mentioned as existing in the least volatile portions of commercial anilines. When the rectifications have been carried so far that a product is obtained distilling at about 200° C. = 392° Fahr., it is to be converted into oxalate. The oxalate of paratoluidine is less soluble than the corresponding salt of orthotoluidine; 100 parts of water at 14° C = 57·2° Fahr., dissolve 0·87 of oxalate of paratoluidine; and 100 parts of water at 21° C. = 69·8° Fahr., dissolve 2·38 of oxalate of orthotoluidine. On decomposing the oxalate with caustic soda, the paratoluidine (mixed with some ortho and meta-toluidines) separates, and is to be distilled. The crystals may be drained, washed with water, pressed, and re-distilled. If the other modifications of toluidine be present in sufficient quantity to retard the crystallization of the para variety, exposure to a low temperature will much facilitate the separation.

Metatoluidine.—This modification was obtained by Beilstein and Kuhlberg by treating the metanitrotoluene discovered by them with tin and hydrochloric acid. Its boiling point is given by them as 197° C. = 386·6° Fahr. Its specific gravity is 0·998 at 25° C. = 77° Fahr. Its acetyl derivative melts at 65·5 C. = 149·5 Fahr. It gives a violet coloration with chloride of lime and hydrochloric acid.

Metatoluidine is contained in commercial "anilines for red;" and in the ordinary toluidine of commerce. It may be obtained from the latter, according to Wroblevsky (*Journal of the Chemical Society*, July, 1871, p. 563), by heating it with rather more than the theoretical quantity of glacial acetic acid for sixteen hours. On cooling, the greater part of the product solidified, but a considerable proportion of toluidine remained uncombined. On distilling it off, and again subjecting it to the same treatment, the product solidified after three days' rest, and consisted of pure metatolylacetamide. The crude product, as separated by distillation, had the same degree of solubility as metatolylacetamide, and its derivatives were wholly distinct from those of paratolylacetamide, and were of great beauty and purity.

Metatoluidine may be obtained from metatolylacetamide, prepared as above, by distilling it with alcoholic potash.

Orthotoluidine.—This variety (the pseudotoluidine of Rosenstiehl) is produced by the reduction of the liquid form of nitrotoluene. It appears to have the same boiling point and specific gravity as metatoluidine. It remains liquid at —13° C. = + 8·6° Fahr., according to Beilstein and Kuhlberg, and even as low as —20° C. = — 4° Fahr. according to Rosenstiehl. It boils at 197° C. = 386·6° Fahr., and therefore at the same temperature as metatoluidine. Its acetyl derivative melts at 107° C. = 224·6° Fahr., and, like metatoluidine, it yields a violet coloration with chloride of lime and hydrochloric acid.

We are now in a position to understand the nature of the so-called "anilines for red," which are, in fact, commercial toluidines containing aniline. Aniline for red is really a mixture of aniline with para, meta, and ortho toluidine. On cooling a commercial toluidine boiling at 198° C. = 388·4° Fahr. to 0° C. = 32° Fahr., it will deposit crystals of paratoluidine; but on draining off the crystals and re-distilling the liquid portion, its boiling point will be found unaltered. This will readily be understood from what we have already remarked upon the boiling points of the three toluidines.

The following boiling points of a good aniline for red will give an experimental confirmation of what has been said as to the composition of this product:

Boiling Point of a Commercial "Aniline for Red."

	T. Deg.	t. Deg.	N. Deg.	Corrected Temperature. Deg
10 per cent. at	188	18·75	118	191·1
20 " "	189	18·75	119	192·1
30 " "	189·25	18·75	119·25	192·4
40 " "	190	18·75	120	193·2
50 " "	190·5	19	120·5	193·7
60 " "	191·25	19	121	194·5
70 " "	192·5	19·5	122·5	195·8
80 " "	193·75	19·5	124	197·1
90 " "	196	19·5	126	199·4

As the boiling point of aniline is 182° C. = 359·6° Fahr., and that of an ordinary mixture of the three toluidines may be assumed at 197° or 198° C., we see at once, from an inspection of the above table, that it represents the composition of a mixture of aniline and the toludines. No reliance can be placed upon the reading against the first 10 per cent., as there is always a certain amount of moisture present. If, therefore, we commence the readings at 20 per cent., we see that the so-called aniline for red begins to boil ten degrees above the boiling point of aniline.

Although the boiling points, as given in the above table, represent those of an aniline for red which gave excellent results, it must not be supposed that it would satisfy every buyer. It should be remembered that a mixture such as we have described is not generally made by mixing pure aniline with toluidine in various proportions. It is more usual

to make them from benzoles containing more or less of the homologues of that hydrocarbon.

Commercial anilines for red vary much in composition; they are often designated "light" and "heavy" anilines. The words "light" and "heavy" are here used, not with reference to their specific gravities, but only with regard to boiling point. Thus, an aniline of comparative purity is called light, and one consisting chiefly of toluidine is called heavy, yet the density of aniline is 1·020 and that of the liquid toluidine 0·998. The densities of commercial anilines vary with their composition—*i. e.*, with the relative proportions of aniline and toluidine present. Thus a so-called light aniline will have a specific gravity of about 1·010, and a heavy aniline will vary from 1·004 (the mean between the densities of aniline and liquid toluidine) to 1·007. It was usual with most makers of aniline for red, and is still so with many now, to prepare it from a 50 per cent. benzole, and the resulting product had a density of 1·009 to 1·010. An aniline of this class yielded on distillation about 50 per cent. below 190° C. = 374° Fahr. (uncorrected). An aniline of this class used to be preferred by some of the principal German manufacturers of magenta. It will be seen on reference to the boiling points of the aniline for red given in the table, that it would appear to have been made from a naphtha containing about 50 per cent. of benzole, because it contains 50 per cent boiling at 190·5° C. (uncorrected), and the principle of correcting boiling points for that portion of the mercurial column of the thermometer not immersed in the vapor has not yet made its way into the laboratories of many tar distilleries, although it will probably do so in time. There are magenta manufacturers who prefer an aniline made from 30 per cent. benzole, which the writer is informed gives an aniline yielding on distillation about 30 per cent. at 190° C. (uncorrected); but, if this be true, it would appear that a benzole of 50 per cent. and one of 30 per cent. yielded anilines of nearly the same character, for we find in the table opposite 30 per cent., 189·25 as the value of T. (or the uncorrected boiling point); but it must be remembered that entire consistency is not to be expected in the boiling points of mixtures of more or less uncertain composition such as these.

Some manufacturers of magenta prefer an aniline giving 95 per cent. at 198 C. (uncorrected) = 388·4 Fahr., while others insist upon 95 per cent. at 205° C. = 401° Fahr. An aniline of this character has been prepared by the writer from aniline recovered from magenta making. It was obtained by using the homologue separator.

Some years ago the writer made an attempt to determine the best kind of mixture for magenta. He offers the results with much reserve, as, while the paratoluidine was pure, the orthotoluidine, although purchased as pure, was not analyzed, and probably contained some paratoluidine and metatoluidine, but in what quantity is not known. The melts were made with arsenic acid with great care. The results are given in comparison with a melt obtained from the finest specimens of commercial aniline for red which the writer has yet seen; the value of which, as a magenta-yielding product, is taken as 100 for a standard. All the experiments were made by printing the trial melts against the standard.

1. Paratoluidine alone gave a dirty scarlet color, but no magenta. 2. The so-called orthotoluidine alone gave on printing a color equal to 50 parts of magenta; this shows that it was not pure, as Rosenstiehl has shown that his pseudotoluidine (orthotoluidine) gives no red compound when heated with arsenic acid; but a mixture of it with paratoluidine yields a large quantity of magenta. He also states that a mixture of orthotoluidine and aniline treated with arsenic acid yields a large quantity of a red coloring matter resembling fuchsine, but distinguished from rosaniline salts by the solubility of its base in ether, and other characters. 3. Two parts of the impure orthotoluidine and one part aniline gave a shade equal in depth to 30 parts of magenta; but the product was very poor and yellow. 4. Paratoluidine two parts, and one part of pure aniline, gave a red shade equal in depth to 33 parts of magenta. 5. Orthotoluidine four parts, and paratoluidine one part, gave a print equal to 90 parts of magenta. 6. Orthotoluidine two parts, and paratoluidine one part, gave a print equal in depth to the standard—*i. e.*, 100 parts of magenta. 7. Orthotoluidine three parts, and paratoluidine one part, also gave a print equal to the standard. 8. Equal parts of the impure orthotoluidine and pure paratoluidine gave a shade equal in depth to 66 parts of magenta.

The writer, while again admitting that the uncertainty attending the composition of the so-called orthotoluidine used by him is to be regretted, would suggest that one inference may be drawn from the above experiments, namely, that those manufacturers of magenta who insist upon the highest boiling points of the so-called anilines for red are in the right; and as ortho and meta-toluidine boil at 197° C., and paratoluidine between 198° C. and 200° C., the mixture for magenta should contain a considerable proportion boiling between those temperatures.

TEXAS IN ITS GEOGNOSTIC AND AGRICULTURAL ASPECT.

By J. Boll.

Having resided for several years in Texas, during which time I have constantly been engaged in scientific researches, I shall, in this article, aim not so much at a geological and geognostic description of the country, as attempt to present results already made known by others, and to give a slight view of my own observations in the same field. I shall not undertake a description of rocks and minerals heretofore found in Texas, nor enumerate animals already known as extinct or as still existing; but rather, from the nature of the soil and the constitution of the mineral kingdom, draw my conclusions as to the fertility and products of the different parts of the State.

Of the various publications by other persons on the geologic and geognostic conditions of Texas, the following are known to me:

1. Texas, with Special Reference to German Emigration and the Physical Condition of the Country, as described after Personal Inspection by Dr. Ferdinand Roemer, together with a Scientific Addendum. Bonn, 1849.
2. The Chalk Formations of Texas, and their Organic Contents, by Dr. Ferdinand Roemer. Bonn, 1852.
3. Exploration of the Red River, in 1852, by Rand. B. Marcy, in which the Northwestern Part was Geologically described, by Geo. R. Shumard.
4. The Annual Reports of State Geologist Buckley.
5. The Map of Texas, by A. R. Rössler. 1874.

The geographical character of Texas, as Roemer correctly remarks, divides it into three districts, more or less sharply defined. These are:

1. The Lowlands, along the whole coast, from the Sabine to the Rio Grande. They vary in width from thirty to a hundred miles, rising from three to a hundred feet above the sea, and are really only a continuation of the coast lands of Louisiana, Mississippi, and Alabama, and therefore belong to the same diluvial and alluvial formations, being almost wholly composed of clayey and sandy deposits. However, it is not alone the rivers coming from the interior which collect and bring down this material, for the sea also contributes its part. As proof of this, we find in the soil, not only the remains of marine animals, but the animal and vegetable world still extant gives evidence thereof. Here, not only on the coast but in the whole region, we find those plants and insects living near salt water only. The long narrow islands lying along the coast of Texas must necessarily, on account of their situation and physical condition, be considered as parts of the Lowlands.

2. The Hill country, or Uplands. This consists of the prevailing level and hilly region between the lower coast-range and the higher and partly rocky highlands beyond. Its width is from one hundred and fifty to three hundred miles, about one hundred to one thousand feet above the sea. According to its geological composition, it partakes in equal parts of the tertiary and secondary formations. The fertility of its soil is exclusively due to the composition of these formations, hence within it are embraced the fairest and most prolific portions of the State. Large, extensive prairies are situated in the west, with strips of timber along the creeks and rivers, also large and small forests diffused here and there, but composed wholly of post oak. The eastern portion is almost entirely covered with forests of a great diversity of timber.

3. The Highlands. These arise behind the rolling hill-land, beginning in the west on the Rio Grande, where, at its confluence with the San Pedro, it suddenly turns its eastern into a southeastern course. Thence the boundary extends due east to the great sources of the San Antonio; thence northeast to Austin; and thence due north it reaches the Red River near the mouth of the Little Wichita.

From the Rio Grande to Austin, the boundary between the Hill country and the Highlands is well marked and sharp; while from the latter point to Red River the transition is more gradual and more difficult to define. The highest places in it rise scarcely 2,500 feet above the sea, excepting the Guadalupe mountain, west of the Pecos river. In the northwest part of the State, toward New Mexico, the elevation slowly increases toward the Rocky mountains. No higher mountain chains are at all to be seen, and this region has rather the character of a high table-land. The inequalities arise more from the excavations of valleys and ravines, while the elevations generally maintain the same level. In its geological character it is greatly diversified, belonging, as it does, to the tertiary, secondary, and primary formations. In very many places the soil is very dry, sterile, and rocky, especially the valleys in the south, presenting steep and rocky entrances, rarely widening into fertile plains. All the principal rivers of Texas rise in this division, which is but sparsely settled and but imperfectly explored and known.

If now we take under review the formation and composition of the soil of these different parts of the State, the following will be the result as to their fertility and products:

In general we distinguish three different kinds of soil—sand, clay, and limestone—in the first, sand or silica predominates; in the second, clay; in the third, carbonate of lime. Neither of these constituents alone is sufficient to produce a vigorous growth of plants; that this is the case with sand is proved by the great deserts of Asia and Africa. When sand constitutes more than nine-tenths of the soil, vegetation cannot flourish; yet all soils require a certain proportion of sand, because every plant needs some sand for its growth; for cereals especially this element is indispensable. The clay soil has also its defects, it is too tenacious, so that the roots cannot spread out; it retains water too long, and when it dries it hardens into tough lumps; it has, therefore, precisely the opposite faults of sand, wherefore a proper intermixture of the two proves advantageous. A soil consisting solely of lime varies too violently in moisture and dryness; lime is, however, as indispensable for the nutriment of plants as sand, so that mixed in proper proportions with sand and clay, it proves itself highly advantageous in every respect; hence soils composed of sand, clay, and lime are, without doubt, the most fertile.

Now, as regards Texas particularly, its sandy soil was mainly derived from the sandstone of the tertiary period, while its clay and lime soil deposits came from the tertiary and mesozoic ages.

The soil of the Lowlands is, through the accumulation of sand, clay, and lime, brought into a mixture very beneficial to cultivation, but owing to the presence of salt, and still more to its level surface, which hinders the discharge of water, it is not adapted to every kind of cultivation, wherefore wheat cannot be raised, while Indian corn, sugar-cane, and cotton succeed admirably. The entire Lowlands are not yet extensively cultivated, and its more general culture depends upon a thorough system of drainage. The condition of the soil is everywhere the same, neither stones nor rocks are to be seen.

In the Hill country we find the sandstone, and the sand and clay deposits of the tertiary formation in vast extent, and the peculiarity of it is that these places are, throughout, covered with forests, indeed we may safely conclude that wherever extensive forests are found in elevated positions, they arise from a tertiary foundation. Thus the whole forest-clad parts of Eastern Texas, from Red River down to the sea coast, consists of these formations, the upper and lower cross timbers of Northwestern Texas, like the post-oak forests situated in the middle and southern, rest throughout upon tertiary formations. Since now the soil there, mainly through the influence of the glacial era, was derived from sandstone and sandy clay deposits, it is, therefore, less adapted to the cultivation of plants, having obtained a large share at the same time through a considerable portion of iron, as we shall see later; yet along creeks and rivers are found here and there places fit for cultivation. In the first years of culture, plants flourish generally quite well; but the strength of the soil is soon exhausted, which has strikingly exhibited itself in parts of Louisiana bordering on Texas, this side of Red river. This region has been for a long time thoroughly cultivated, and at this time has only two-thirds of its former extent under culture. Wheat does not succeed in this soil, and cotton is mostly only one to two feet high; corn is weak in the stalk and the ears are small; fruit-trees alone flourish there, viz., peaches and apples, since these trees are enabled to send their roots deep into the ground. Pines, which grow best in sandy regions, diffuse themselves to a great extent through the forests. Since then, by means of forests, we can decide the tertiary foundation of the soil, so in the same way we may state that open prairies and places covered with mesquite trees, indicate that the soil rests upon secondary formations. There again the soil is formed of sand, clay, and lime, through the operation of the glacial era, and mingled together in so advantageous a manner that it presents all those conditions on which depends the perfect development of all cultivated plants. This division embraces that part of Texas which promises to become so large a source of food such as no other State of the Union possesses, even such as can be found in few portions of any continent. Again, in the same division is that region of peculiar importance in which naked rocks appear on the surface, neither to a small nor great extent immediately after the tillable ground has been broken up by other causes. Such a wholly continuous area, more than one hundred and twenty miles wide, and over two hundred miles long, lies in the northern part of the Hill-country of Texas. It forms a long rectangle, of which Dallas county is nearly the center, and this is the reason why this division, and especially the city of Dallas, have so rapidly grown in importance, and this proves at the same time with what keen foresight railroad magnates have stretched their iron roads through this section.

This division is, however, penetrated in its north-western part by the so-called Cross Timbers, two strips of forests from eight to ten miles wide, the soil of which consists of the tertiary elements, but their intermixture through the physical influences of the glacial period, since the extent was not very great, became much superior to that in Eastern Texas. Besides, it constitutes only a very small part of the division under consideration, and supplies at the same time, to the adjacent prairies, convenient and adequate material for fencing and fuel, which only in few places has to be procured from considerable distances.

In the southern and south-western portion of the Hill-country, as far as the Rio Grande, the soil is also composed of sand, clay, and lime, yet, as in the northern part, it is more frequently interrupted by tertiary clay and sand, but much more, and more injuriously to agriculture, is the ground filled with hard, reddish flint stones, from the size of a pigeon-egg to that of the fist. These originate in the Highlands north of it, on one side of the primitive mountains arising there, and still more from the extensive chalk hills. This chalk formation of the Highlands is of a sandy character, hard, and inclosing a great number of sand and flint concretions. After the drift period they remained scattered in every direction, and this readily explains why these concretions are found not only in river beds but also on those higher localities surrounding the valleys, and particularly on hills. The soil of this part of the Hill-country is here and there so filled with these stones that it is useless to undertake a thorough culture of it. Although these places often interrupt the fertile soil, yet the latter comprises a considerable area, and it is especially the river-bottoms which in the southern part of the Hill-country possess an immense productive power. In the valley of the San Antonio river, almost the entire bottom of the valley can be irrigated for a great distance, yet this system of irrigation, constructed by the Spaniards many centuries ago, has already so exhausted the soil of loose, light mineral material, that a rich crop can no longer be reckoned upon excepting here and there.

In this connection the following points may be mentioned. Till now it has always been a problem where the great sources of the San Antonio river, as also of the Comal and San Marcos, have their origin, and why these throughout the whole year continue to break forth from under the rocks with the same force and temperature as well as with unvarying clearness.

Roemer, in his work on the chalk formation of Texas, says that the chalk of the Highlands is proven by its organic remains to belong to a somewhat deeper geognostic horizon than that of the Hill-country, and is therefore older, although it lies higher. It is suddenly separated, steep and sharp, from the latter. He says, furthermore, it is possible that through a fault not apparent on the surface, the chalk of the Highlands near New Braunfels was forced back to higher level, and he believes that such transposition, and also the sudden and steep upheaval of the Highlands, explains the remarkable change in the character of the rocks, and that the abrupt breaking forth of the sources of the Comal at the foot of the table-land has a close connection with it.

Northward, and located somewhat higher, there appears in a singular manner, almost wholly surrounded by the chalk formation of the Highlands, an entirely isolated tract of primitive mountain formation, and it is well to observe that this piece was lifted up through terrestrial forces after the chalk formations had already detached themselves. On this granite are found here and there isolated remains of chalk. Before the glacial era the entire mass was entirely covered with it, and it was almost completely destroyed during this long period, and I might therein discover not only a proof of its later upheaval, but also of the existence of the glacial era; so also other and not yet solved problems may here find a solution. Through the upheaval, the volcanic force extended also to the chalk surrounding the granite.

As already remarked, the chalk of the Highlands is much harder than that of the Hill country; as a collective mass it resisted the upheaval, and was therefore lifted up at once with the granite: hence the steep declivity at the foot. By the upheaval considerable cavities would be formed in and under the chalk, for it is everywhere much cleft, and the rain falling on the ground finds its way slowly, therefore, partly through the rocks, into the cavities. It can accumulate in large quantities in these hollows; the water must necessarily find an outlet again, and thus it is probable that the above named rivers come from one or more subterranean lakes, and hence their uniform force, temperature, and clearness. The water of these springs holds a great deal of carbonate of lime in solution, which shows that in the course of time the cavities are more and more enlarged; this view opposes at the same time the opinion that the water takes its origin in the Staked Plains of Northwestern Texas; if this were the case they must contain not only the carbonate but also the sulphate of lime in considerable quantities, since gypsum is extensively diffused there.

Passing now to the Highlands, which embrace the whole remaining part of Texas; it is the largest but the least satisfactorily known. The tertiary formation is very little diffused, and hence the soil is mainly derived from primary and secondary deposits. Nowhere are found extensive tillable and continuous tracts as in the Hill country; the good planting ground is mostly confined to the river bottoms and valleys; only in particular counties are larger tracts of tillable land to be obtained. As already remarked, this high table land is mostly rocky, dry, and sterile; but owing to good meadow grounds, it is particularly well adapted to cattle raising, which therefore is followed in a very extensive manner.

These Highlands have, however, for Texas a particular importance in other respects; it is mainly there that mining will, in future, be prosecuted.

As regards the evidences of mineral wealth, we need not, for known reasons, look for them in the surface of the Lowlands. The whole of the Hill country encourages no hope of rich mineral treasures. Throughout this entire division, however, coal has been discovered in many places; but, according to all scientific principles and personal observations, I must declare that there has been found no coal belonging to the genuine coal formation; but only such of the tertiary and secondary periods—the so-called lignite or brown coal. It is, also, nowhere found in extensive and vast deposits, rarely easy to work; although that of the secondary division, as approaching nearer in age to genuine stone coal, possesses in a considerable degree the elements of fuel. In many parts of the undulating Hill country are found masses of petrified wood. As Roemer already correctly concluded, this belongs to the tertiary formation; and we can, therefore, by this means decide with certainty upon its presence there. The immense proportion of silex in this formation has petrified the wood, instead of carbonizing it.

On the bank slopes of the Red River, near Shreveport, I found a layer one to two feet thick, which was half carbonized, and half petrified; and in the same stratum lay large logs of cypress in a half carbonized and half petrified state.

The large deposits of iron ore in the tertiary formation of Eastern Texas may become of somewhat more importance than the coal in the Hill country, but they by no means equal in value the ore deposits of older origin. The iron is here found mainly as iron sandstone, and in many counties, as in Henderson, Anderson, etc., in such quantities that the whole range of hills are formed of it; and the region presents many times, by their rocks and the ravines between, a quite romantic character; this is particularly the case with the so-called big rocks between Vanzandt and Henderson counties. The tertiary formation is also rich in salt deposits, and in many places the salt is successfully obtained from salt springs. In the iron regions we encounter in some places very strong mineral springs, especially sulphur springs. They hold in combination much carbureted hydrogen gas and sulphuret of iron; when they come to the surface, they liberate blackish gray and yellowish precipitates of sulphur and sulphuret of iron; but they do not come from any considerable depth like thermal springs, since they have nearly as low a temperature as the ordinary springs of the neighborhood. On the Neches River, as well as on the Sabine, I found larger deposits of a blackish iron sandstone, which was quite loose and brittle; it holds iron mostly as sulphuret of iron. Owing to its slight coherency, the latter may, through several influences, be easily decomposed, and then on the one side give cause to the sulphur springs, and on the other to the sulphate of iron produced in that region. There are also many beds of clay, which contain alum, or bitter salt, and impart for this reason a strong taste to the water; in particular places, in summer, there is seen in the bottom of tumblers, after the evaporation of the water, a white crust of this salt. Of greater importance to mining in Texas are the Highlands.

From the mouth of the Little Wichita into the Red River down to the Colorado River, where the Pecan bayou empties into the same, there lies, towards the west, a region about one hundred miles wide, that belongs to a much older mountain formation, the so-called coal or transition mountain. In this is found in abundance the copper-schist or the Permian system, as also the Silurian. Shumard looked already upon this region as belonging to the coal formation; and the organic remains which exist in the rocks speak most plainly; such are trilobites, fossil fishes of the families of Ganoids and sharks, and the imprints of the ferns with Equisetaceous and other plants. I have found also in this formation various mollusca, chiefly *Brachiopoda* and *Lamellibranchiata*, wholly petrified in the iron ore, called sphærosiderite. We find now and then, on the surface of this coal formation, copper core, consisting mainly of malachite, which originally penetrated in veins through sandstone; it is often several inches thick. There are also found immense masses of iron ore in very many different conditions, lying around loose on the slopes, in ravines, and everywhere; and especially those that appear most numerous, are the hematite and ironspar or sphærosiderite, and which, it seems, have been taken by some persons for copper; yet I have no doubt but that considerable copper and other ore deposits may still lie bidden in some deeper stratum. The different iron ores contain, according to my analysis, twenty to seventy per cent. pure iron, and among them many spars, a little zinc, and traces of cadmium. If we compare these ores with those of other countries, it is apparent that they are among the best, and most easily reduced; they are the same ores out of which nearly nine-tenths of all the iron in England is produced.

From these geological and palæontological facts, we are permitted with all certainty to conclude that, although hitherto no positive data have existed, there must be throughout this whole division large, extensive, and genuine coal beds. In the geological State museum at Austin can be seen large pieces of genuine stone coal, but without any precise information as to the place of discovery.

Bismuth and antimony, it is claimed, have already also been found. Some time ago the newspapers gave information that a very rich silver mine had been discovered in Montague county; but it may well be doubted whether this news is correct, and it may have been published from interested motives. Gold, silver, lead, and molybdenum are, however, found in the previously mentioned primitive mountain formation of the Highlands, where in later times, in Llano county, a silver mine is said to have been put in operation. Westward of the coal formation, particularly along Red River and in the Staked Plains, lie very large beds of gypsum; but the future must reveal to us how large treasures in metals lie in the still unknown regions of the west.

If we cast a retrospective look over the whole, we may assert with all certainty that Texas is approaching a very promising future. It is a country in which, on account of its fine and favorable position, not only all the plants of the temperate zone flourish, but also many of those of the tropics. The wine culture, to which many a State owes its prosperity, is yet in the germ; but the results attained on a small scale hitherto, the great number of excellent wild grapes, as also the above described constitution and combination of the soil—are all speaking evidences of its adaptation to this noble fruit.

Texas has its own pine forests in the east, which will be fully adequate to supply the whole State with lumber, and to fence in the fields. In the interior it has its own granary; and when once her own hand has wrought her own iron with her own coal, then will she supply not only her own wants, but many of those of the outer world.

Nowhere are there extensive swamps which make residence unhealthy; the country has also no sections which suffer from excessive drought. Winters have neither the northern cold, nor the summers the tropical heat; and pleasant breezes throughout the whole summer keep the air continually, not only in a refreshing condition, but contribute much to the salubrity of the country. Though we may not have to point out lofty, romantic mountains, still there are regions highly favored by nature, particularly those about San Antonio and New Braunfels, with their mighty springs, and their ever clear and refreshing water, that are especially noteworthy; which places, if they were lying on the sea, would justly be called the Texan Nice.—*American Naturalist.*

MAKING A POOR SOIL FERTILE.

About ten years ago I became the owner of a large tract of land, the greater portion of which being sandy and leachy was considered of little value for agricultural purposes. The experience of those who had cultivated adjacent tracts of like land had been that it would produce two or three good crops in favorable seasons, and the fifth and sixth crops (unless the land was well manured) would not be worth harvesting, as by that time the organic matter which had accumulated since its formation would be almost entirely exhausted, leaving little besides pure sand remaining. The general experience of practical farmers was that they "would not fence that sandy land for it." A few weeks ago one of the oldest farmers in this country remarked to the writer, "I have seen the time I would not pay ten cents an acre for the land where your farm is."

After became the owner of this apparently worthless tract, the question was what I should do with it, and how I could make the investment pay. Never having "plowed a round" in my life, my knowledge of farming was confined to such observations and such information as a business man gathers from conversation with those following that pursuit. Holding to the belief that land that has once produced good crops can be made to do so again, the only question then to be settled was in what way it could be done with the least outlay of capital and labor. My experience in business had taught me not to "put too many eggs in one basket," and in whatever branch of business a man engages (although he may profit largely by the experience of others), before he obtains a thorough practical knowledge of all its details, he often finds that his schooling has been an expensive one.

In the spring of 1870, I inclosed with fence about one-sixth of this tract; planted it with corn, and gave more than usual attention to reading agricultural books and papers, expecting to find therein some simple and inexpensive method which had been thoroughly tested for keeping up the productive standard of the farm—some method that would not involve a largeo utlay for expensive fertilizers, or a considerable investment of capital in stock and waiting its slow return—in short, some plan whereby the land could "work out its own salvation."

My reading almost converted me to the belief that the care and cultivation of land was one of the "lost arts," and upon the all important question of how to make impoverished land resume its original productiveness, I found there was as great diversity of opinion, and as many impracticable plans suggested, as has been for resumption on the part of the general government. All that I could gather from my extended research that was applicable to the case in hand, was that the clover would grow on sandy or other poor soils, and that a dressing of gypsum or land plaster would increase the quantity grown. Believing that if clover could be made to grow on that land, it would prove the lever that would hold it up, and possibly, by judicious rotation, increase its productiveness, in the spring of 1871 I had eight quarts of clover seed to the acre sown with oats, and gave it a top dressing of one hundred pounds of land plaster to the acre. A part of the land thus seeded (about an acre), had for several years been used as a public highway; on that part the soil was so thoroughly exhausted that it would not have been a difficult task to have counted the stalks of oats that matured on it; but the clover was thick and good, and the following June a fair crop of clover hay was taken from it. Outside of the line of the old road the oats yielded a fair crop, but there was to be seen after harvest only a few bunches of clover. My subsequent experiments have demonstrated that oats are the most hazardous of all the small grains to seed with, and that when land is very poor it is not advisable to sow grain with clover with the expectation of getting much of a crop. When I wish to get a sure catch of clover on poor land, I sow four or five pecks of oats with eight quarts of clover seed to the acre, and give it a top dressing of gypsum. The oats sprouting and rooting quickly prevent the light soil from blowing off and exposing the tender sprouts of the clover seed, and to some extent the oats act as a shade to the young clover plant and keep it from burning out before it becomes sufficiently rooted.

It would occupy too much space to give in detail all my experiments (inexpensive ones, however) on this tract of land. It is sufficient to say that clover is my main dependence for keeping up and increasing its productiveness. The entire tract (300 acres) is now under cultivation, and the annual yield to the acre of wheat, rye, corn, and clover hay will average with the best land, in Wisconsin or Iowa, which has been the same number of years under cultivation. My favorite plan is to have one field each of clover, corn, and wheat every year. This makes a three-year rotation. The first crop of clover is cut for hay in June. The second crop is allowed to go to seed and plowed in late in the fall; in the following spring it is planted with corn; the next spring sown with wheat, and the land will be found to be abundantly seeded to clover. The clover is dressed with 100 pounds of land plaster to the acre. The manure made on the farm is spread where most needed.

It is sometimes desirable to let the land remain in clover for a longer period. My experience is that clover, being a biennial plant, will winterkill the third winter after sowing, but leaves behind a great mass of roots that wonderfully enrich the soil. Land laid down with clover is better than money in bank, drawing more interest than any bank can pay and compounding the interest oftener.

Boussingault took a portion of pure sand, burned it until all traces of organic matter were expelled, then took up some growing clover plants, washed them clean, removed the external moisture with blotting paper, weighed them, and set them in the sand. He then watered them with distilled water, placed them in the air, and in two months' time found that they had tripled their amount of organic matter—thus proving that air, pure water, and sand have all the elements necessary to sustain the growth of clover. In rich soil the results would doubtless have been increased, but we see in this little experiment the elements of all successful agriculture. Had he buried the perfected plant in his sand, and planted again, and continued the process, it is evident that there would be no end to the amount of fertility which might be accumulated, and this would not be in an arithmetical, but in a geometrical ratio, for the presence of manure in the soil would make it easier to accumulate still more from the atmosphere.

Early in the month of September, 1877, I plowed a field of 43 acres of well-worn land, from which a crop of rye had been harvested the preceding July, and sowed it again with rye. In November, cattle and horses were permitted to run on it, and continued to do so until March—no snow covering the ground. Early in May the rye averaged nearly three feet high, and was beginning to head out, when the plows were set in motion, and the green, juicy rye was turned under and the field planted with corn. The yield was 44 bushels of No. 1 shelled corn to the acre. There was less labor and expense attending the plowing and sowing of that rye than there would have been to have hauled sufficient manure from my own barnyard, even if I had had the manure to have spread on the land to produce the same quantity of corn that plowing in the rye did. Again, the corn did not require one-half the labor to keep it clean that it would have done had ordinary barnyard manure, full of all kinds of seeds, been spread on the land and plowed in before planting. Rye is the best of all the small grains to clean land from weeds. The late fall and winter feed which the rye furnished to the stock was of more value than the seed sown.

Some farmers make a practice of sowing rye among their corn in July, just before cultivating the corn the last time. The rye does not make much growth until the corn is ripe and the deadened leaves let the sun on it. After the corn is picked the cattle are turned in, and thrive on the stalks and green rye. In May the rye and what is left of the stalks are plowed in, and is said by those who have practiced it to increase the yield of corn ten to fifteen bushels to the acre. There is abundance of evidence that heavy clay lands that have been worn out by successive cropping can be restored to at least their original fertility by the same process that I have found so beneficial on sandy land.—*Crawford, in Country Gentleman.*

ESPARTO GRASS TRADE OF TUNIS.

The following detailed account of the manner in which the esparto grass is collected and shipped is given by the English Vice-Consul Dupuis on the subject. Although more goes to Great Britain from Susa, yet the quantities collected on the more southern coast and shipped at Sfax and Gerba are very considerable, and may eventually exceed those at Susa, on account of shortness of distances and conveyance by water, rather than by camels, which is always costly. It is brought during a few months of the year, loose in bundles, from a number of places to Sfax and Gerba in boats averaging from two to twenty tons. A good deal comes from Shebbah, some 35 miles to the north, and not an inconsiderable quantity by land transport from Agareb, 20 miles inland. From the hills of Hamamah also and Zluss large supplies have lately been sent. Much comes from Shirah, 50 miles south, during four months of the year. At two or three days' journey inland from Susa the grass grows over a large tract of country, as is the case at Gabes, a name pretty well known, and some 30 miles further south round the coast. Here, likewise, the Akariat flows into the sea, being one of the few rivers in the country which sends water to the sea all the year round. It irrigates a strip of land about half a mile in width on its left bank, extending many miles up its course, and a luxuriant vegetation appears in strong contrast with the bare plains around. The staple product is the date of the different qualities consumed in the country. The last mile of the channel of the river forms a tidal harbor, which admits of the passage of boats up to seven tons burden only. Yet considerable trouble is experienced by them in bringing down the grass when the sea is at all rough, on account of the bar formed by the accumulation of sand at the entrance. It sometimes also happens that navigation is altogether suspended from the choking up of the passage for the waters, and the sand has to be cleared away at considerable cost and labor. It is to be noted too that loaded boats can only pass freely up the river during the ten days at spring tides, and empty ones during five days at neap tides. The right bank of the river close to the sea is high and steep, and the bundles of grass have to be pitched over into the barges beneath. Sometimes, without any other contrivance than what can be supplied by the rigging and a few planks, bales are put on board.

Shipments are made from the port of Susa direct to England, but owing to the bad holding ground and the shallows, vessels loading lie twelve miles to the northward, where they find good anchorage some two miles from the shore. The bales of grass are first weighed near the river, and then put on board the lighters as described, during the ten days of spring tides. If, owing to the neap tides, the lighters cannot approach, bales are carried down half a mile over the sands, below the bar, where they are easily shipped if the water is at all smooth, and the wind from the land. Zarat, 25 miles further south, is another station from which supplies are drawn. Its small harbor is formed by the narrow estuary of a stream, which runs only after heavy rains. Green or Burgreen, about 80 miles from Sfax, is another place which furnishes large supplies. It is brought from a distance of half a day's journey at the nearest, to three or four at the farthest. It is to be understood that the supplies near the coast become soon exhausted, and only if prices offer well can they be sought for at a distance.

These are the principal stations where the grass is collected. At Shirah and Green there are no villages near the shipping places, and the agents have to camp out. At Zarat there is a small one, but some distance off, where there is a tepid spring which irrigates groves of palm and other trees. At the former two places only brackish water is to be had. Though at Gabes it is plentiful, yet it is all hard and brackish.

Besides the mentioned places, there are those of minor importance, such as Bugarah, in the bay indenting the land opposite to the island of Gerba, and Zerzis, a port 30 miles from the Tripoli frontier, where good anchorage is to be found even for large vessels if it were opened to foreign trade. The following is the way in which the grass is collected: Much is brought by the Arabs themselves to the markets. Money or goods are often paid or consigned in advance for grass, which is to delivered at some indicated shore station. Advances are also made for that which is yet to be pulled and got ready for transfer, when animals have to be hired to bring it to the coast. Buyers are sometimes sent out to an Arab encampment, which serves as a center, and take with them money or goods (the latter generally), oil and cloth (last year, barley), which they barter for the grass, and then bring to the coast.